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Pingleton et al.

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(54) **BLADELESS OBTURATOR**

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Related U.S. Application Data

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(51) **Int. Cl.**

A61B 17/34 (2006.01)

A61B 17/02 (2006.01)

A61B 17/32 (2006.01)

(52) **U.S. Cl.**

CPC **A61B 17/02** (2013.01); **A61B 17/3417** (2013.01); **A61B 17/3478** (2013.01); **A61B 2017/320044** (2013.01); **A61B 2017/346** (2013.01); **A61B 2017/3456** (2013.01)

(58) **Field of Classification Search**

CPC B23B 51/10; A61B 10/06; A61B 10/0283; A61B 10/0275

USPC 606/79, 80, 159, 167, 170, 180, 185; 408/83.5, 227, 229, 230; 600/564-568

See application file for complete search history.

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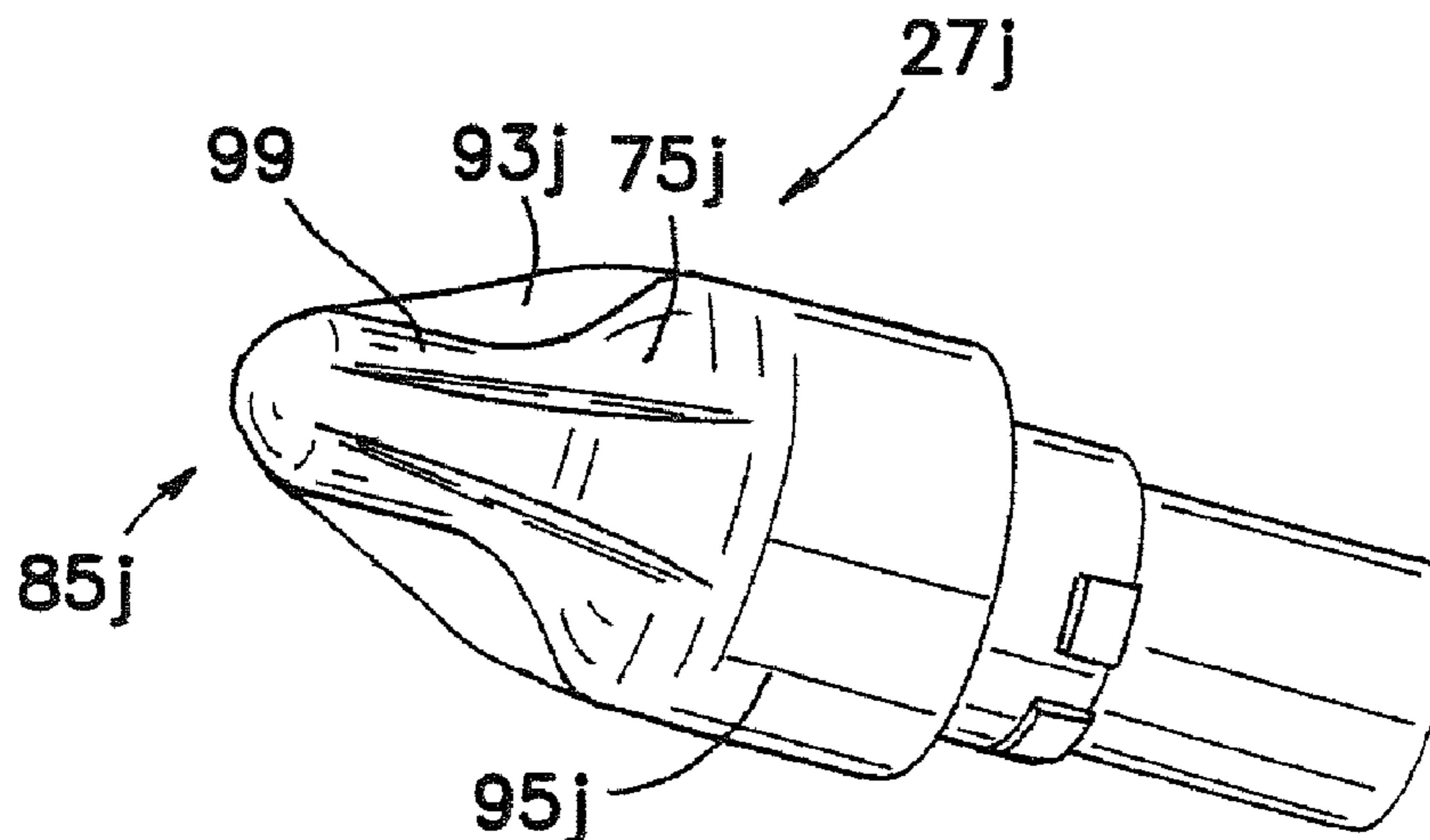
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(57) **ABSTRACT**

A surgical obturator adapted to penetrate a body wall includes an elongate shaft having an axis which extends between a proximal end and a distal end. A bladeless tip, disposed at the distal end of the shaft has an outer surface which extends to a blunt point. The outer surface has a pair of side sections separated by an intermediate section. The side sections extend from the blunt point radially outwardly with progressive positions proximally along the axis. These side sections include a distal portion in proximity to the blunt point, and a proximal portion in proximity to the shaft. The distal portion of the side section is twisted radially with respect to the proximal portion of the side section. The outer surface in radial cross section has the general configuration of a geometric shape which rotates in a first direction about the axis with progressive proximal radial cross sections along the axis.

17 Claims, 13 Drawing Sheets



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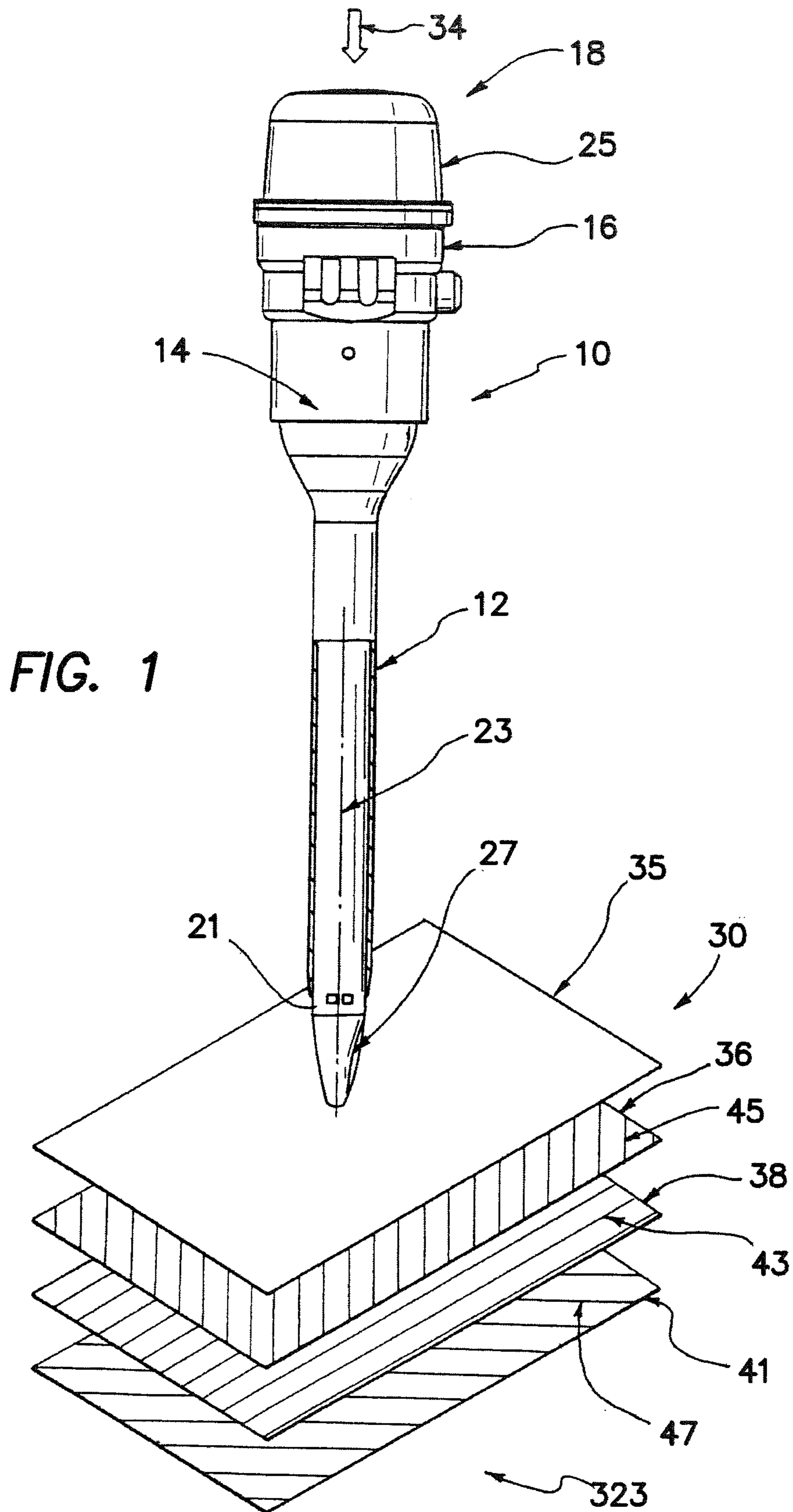
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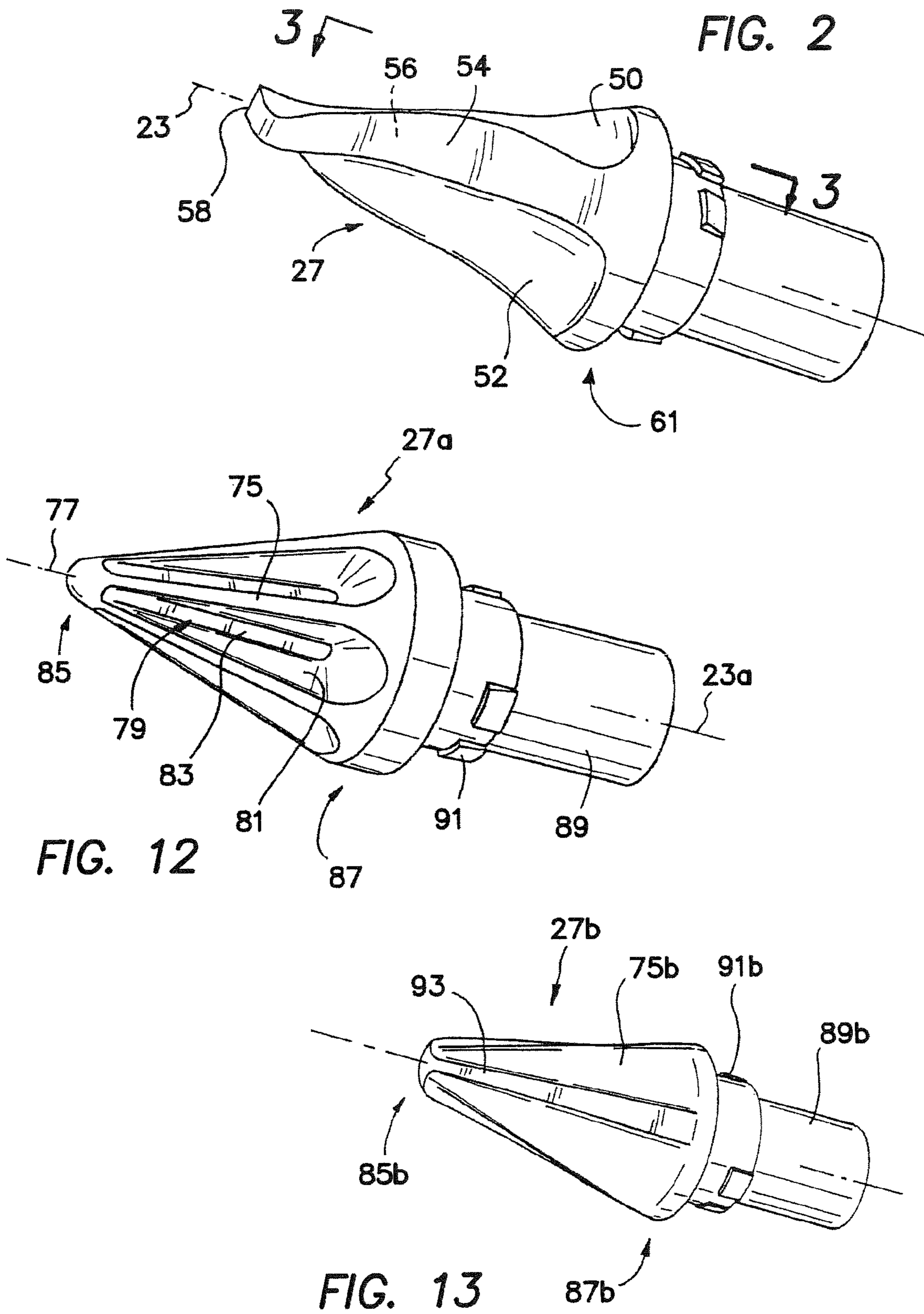
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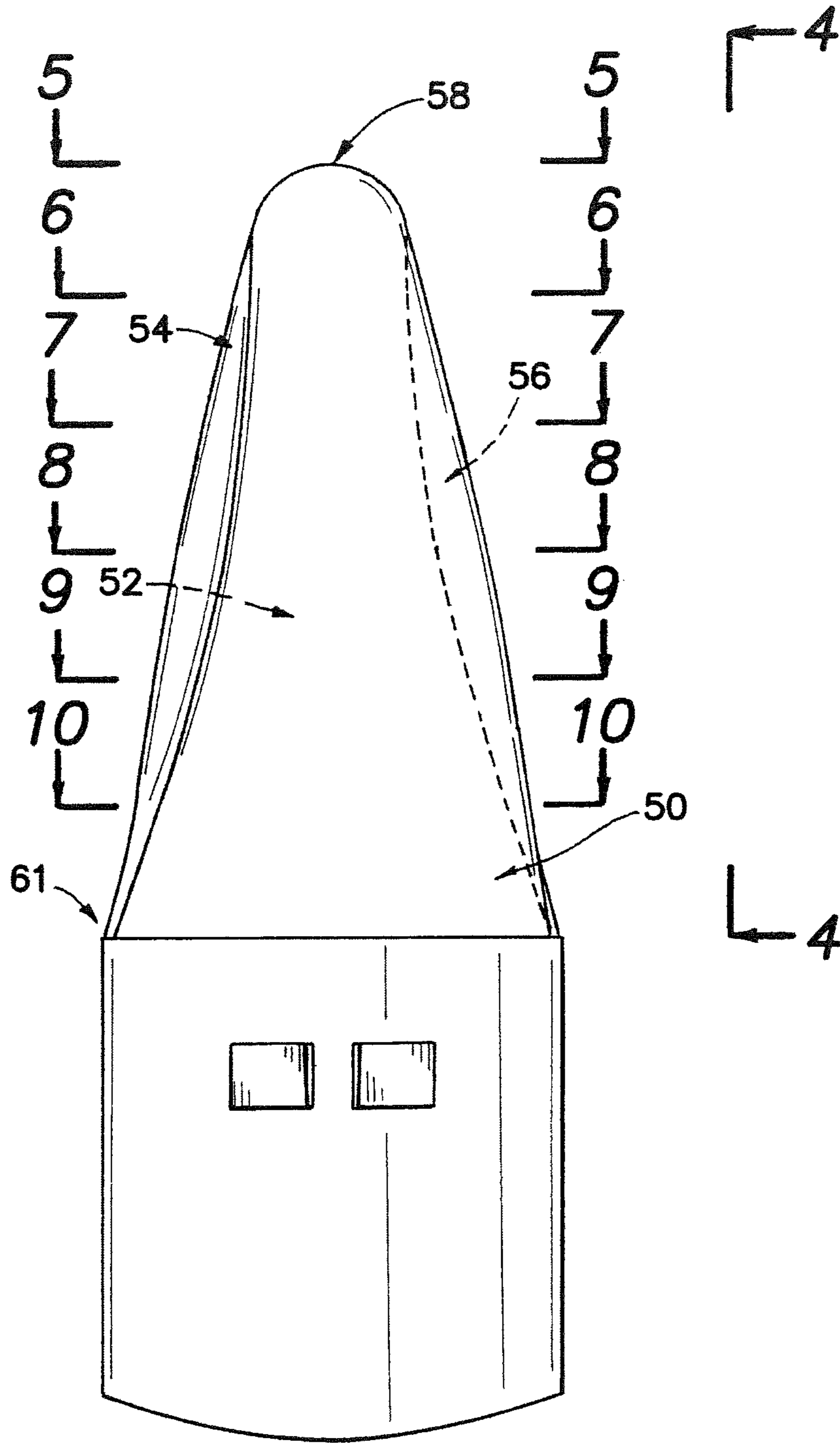
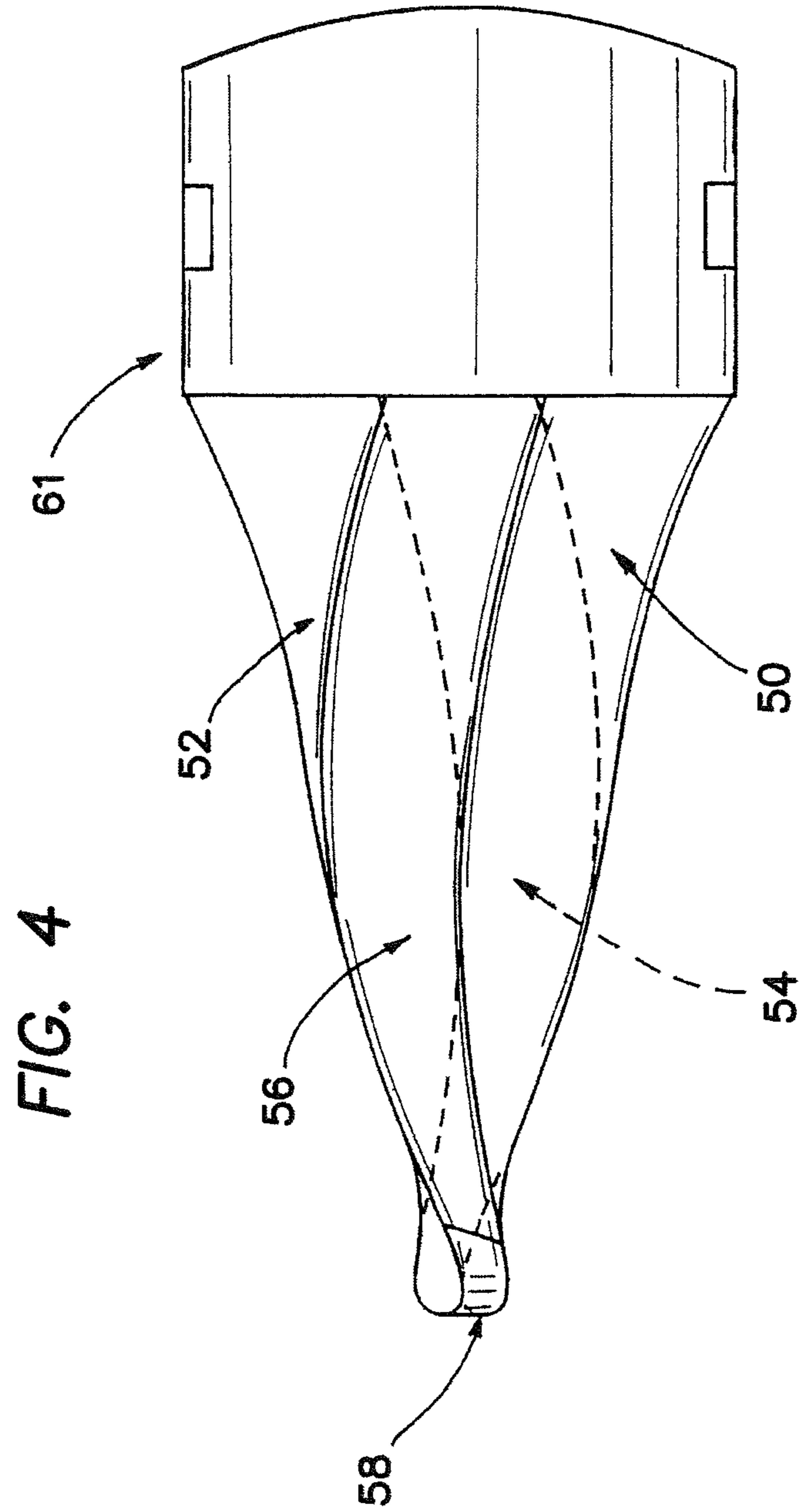


FIG. 3



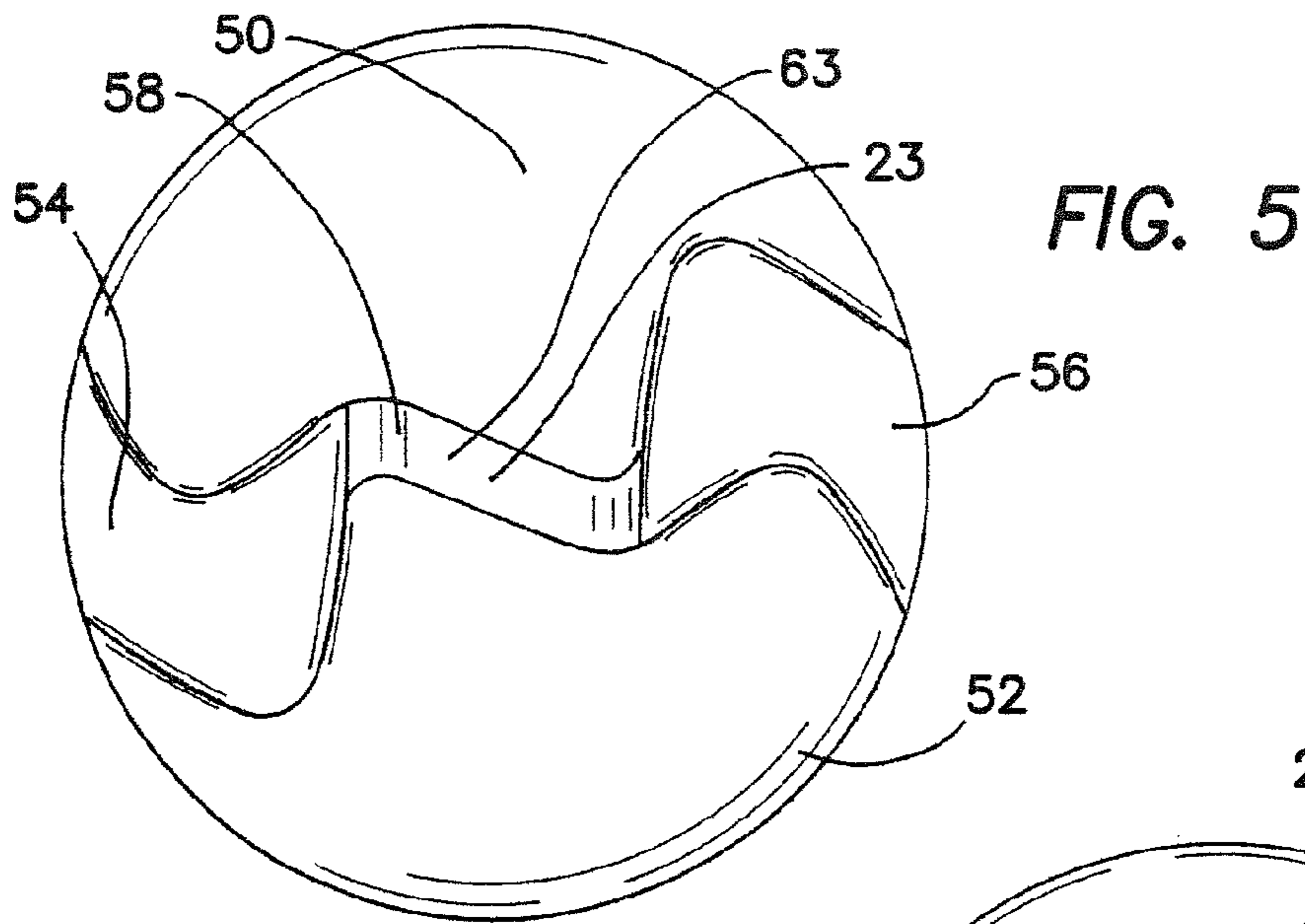


FIG. 7

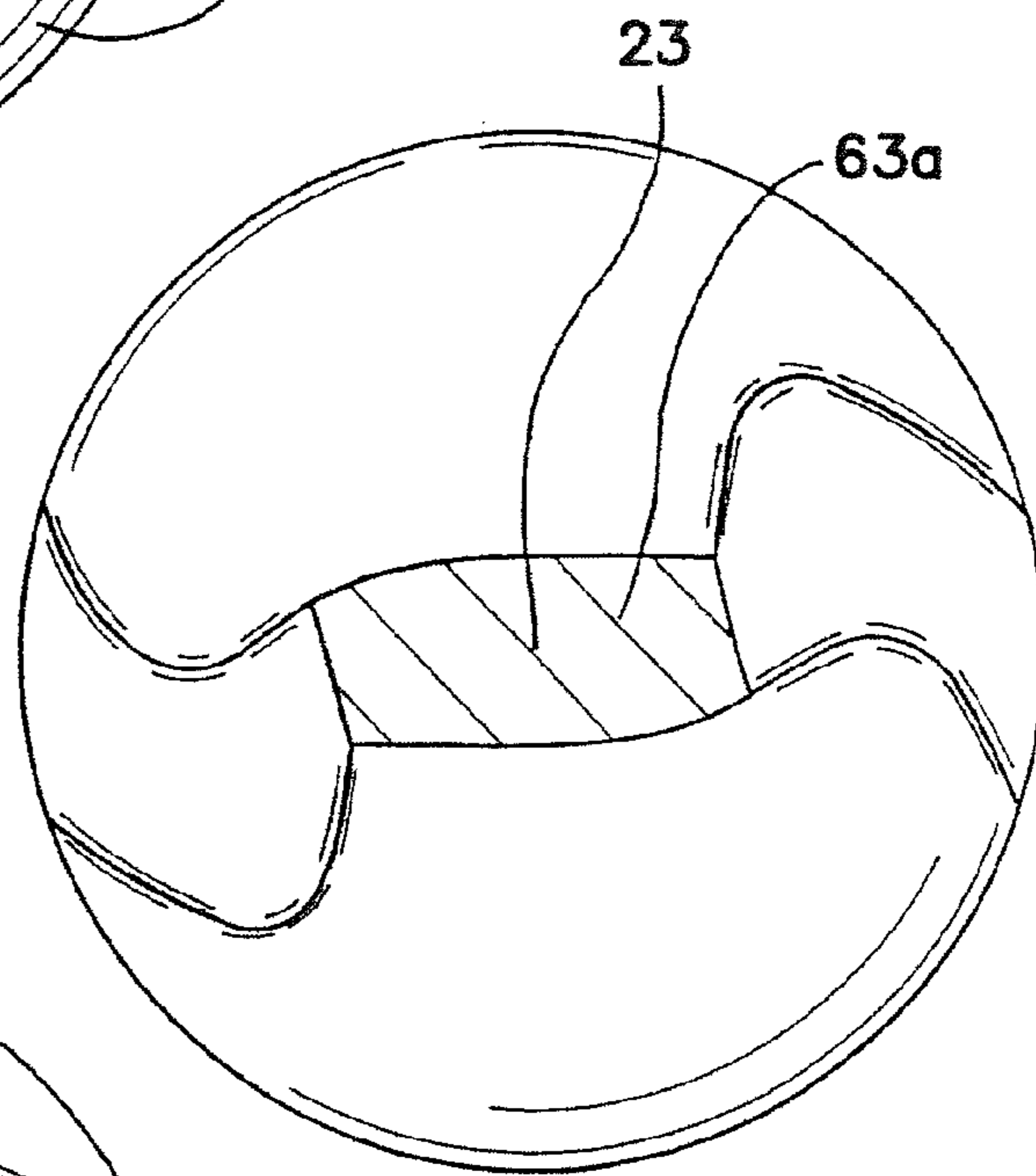
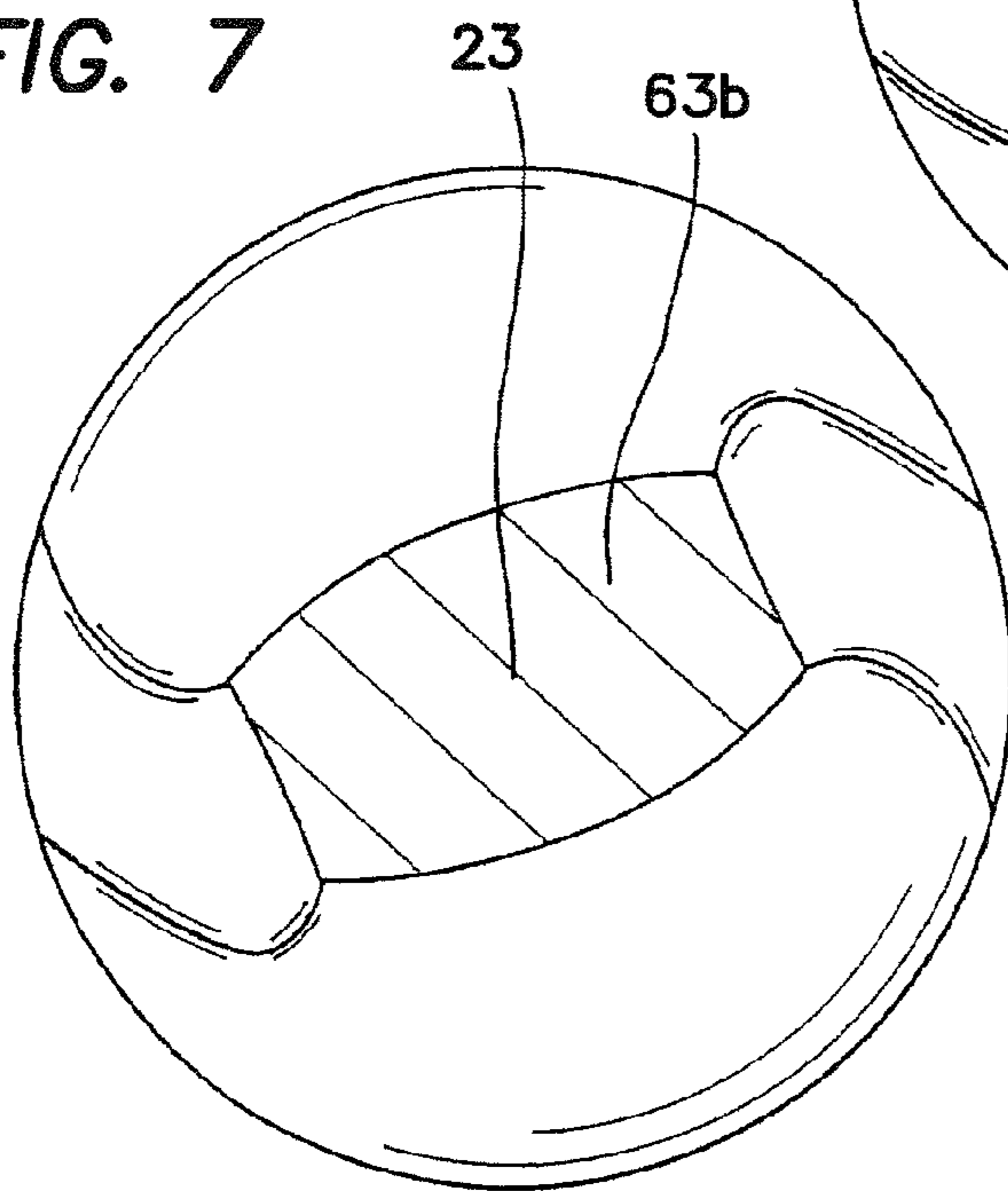


FIG. 6

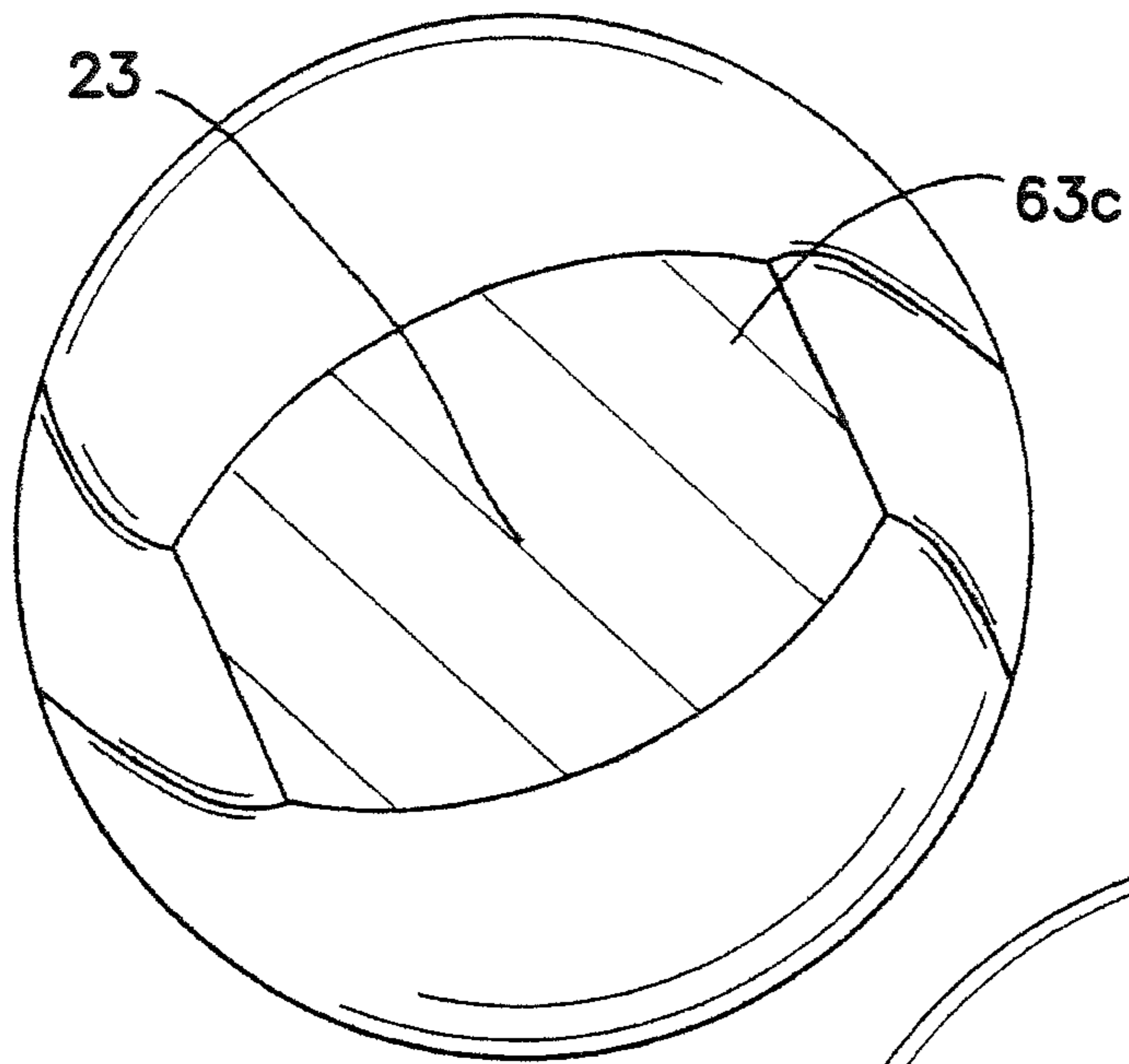


FIG. 8

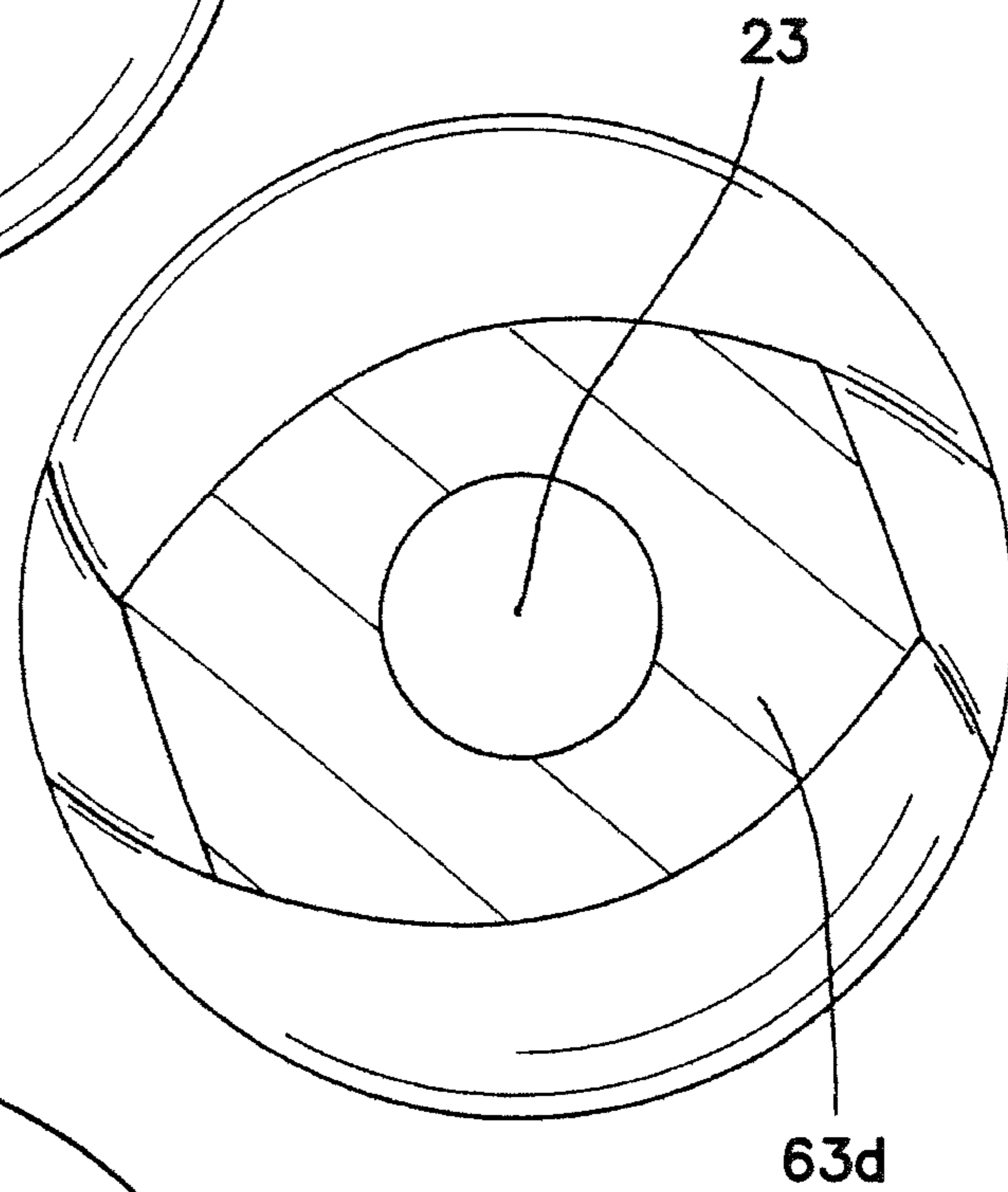


FIG. 9

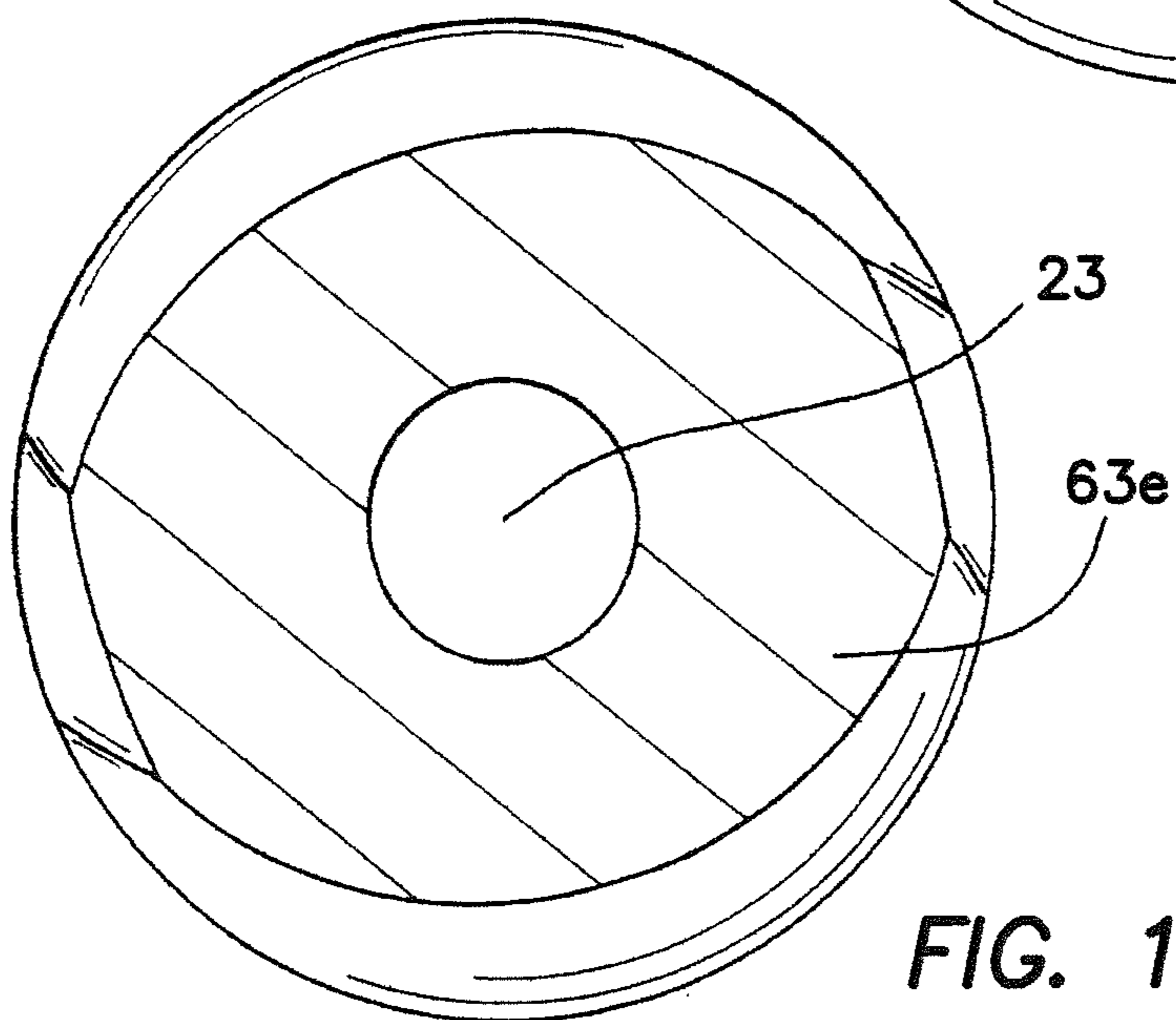


FIG. 10

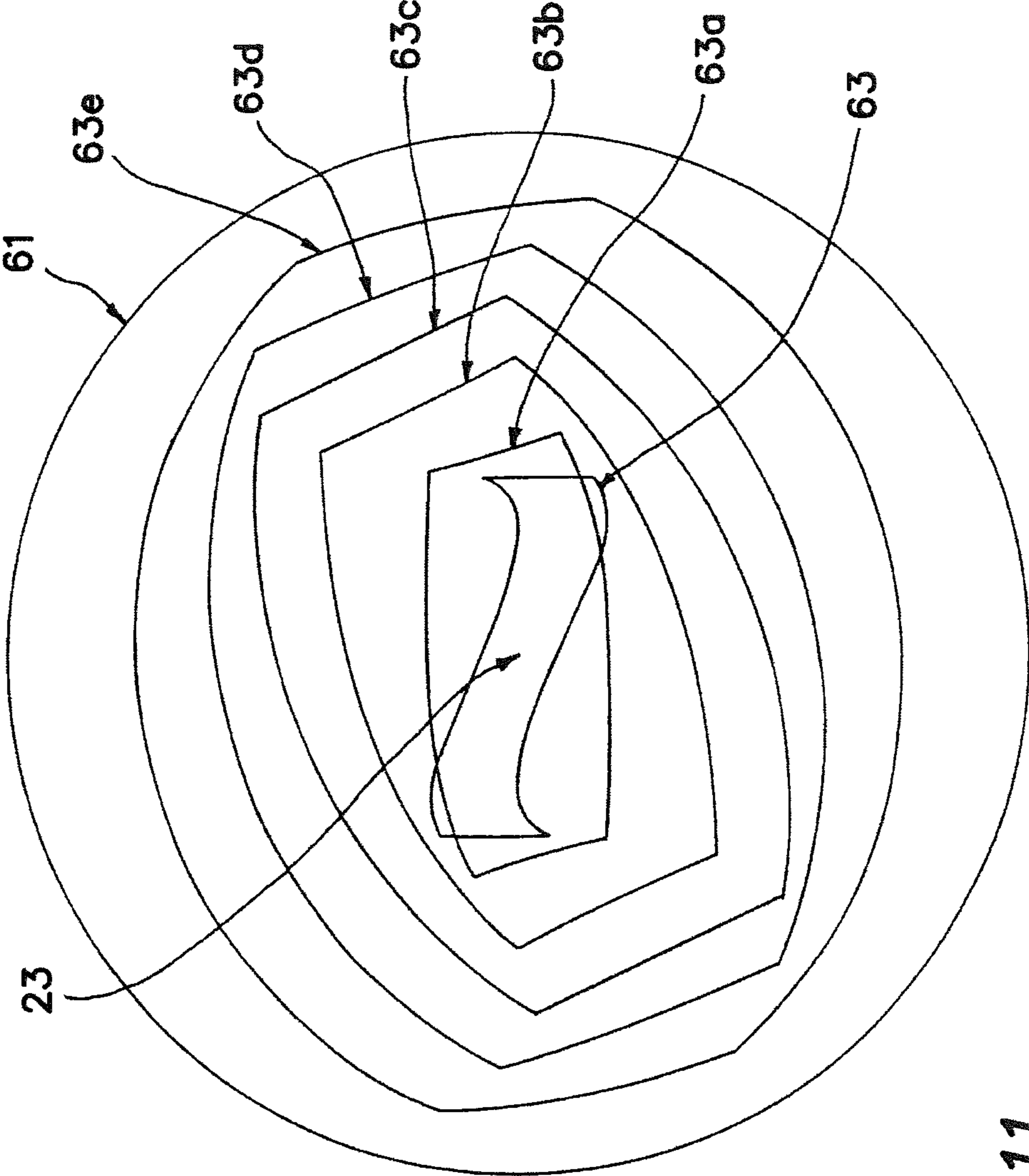


FIG. 11

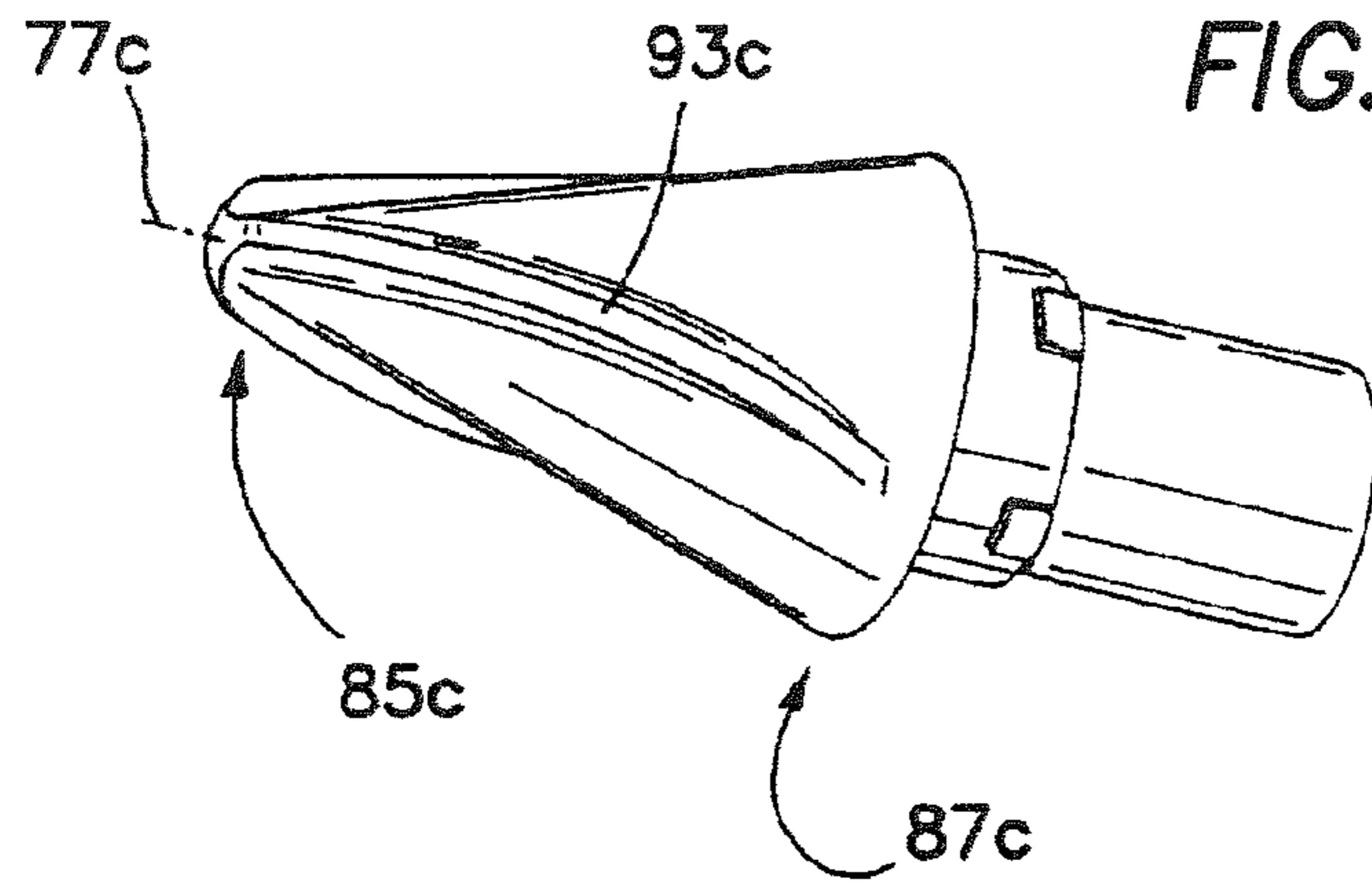


FIG. 14

FIG. 15

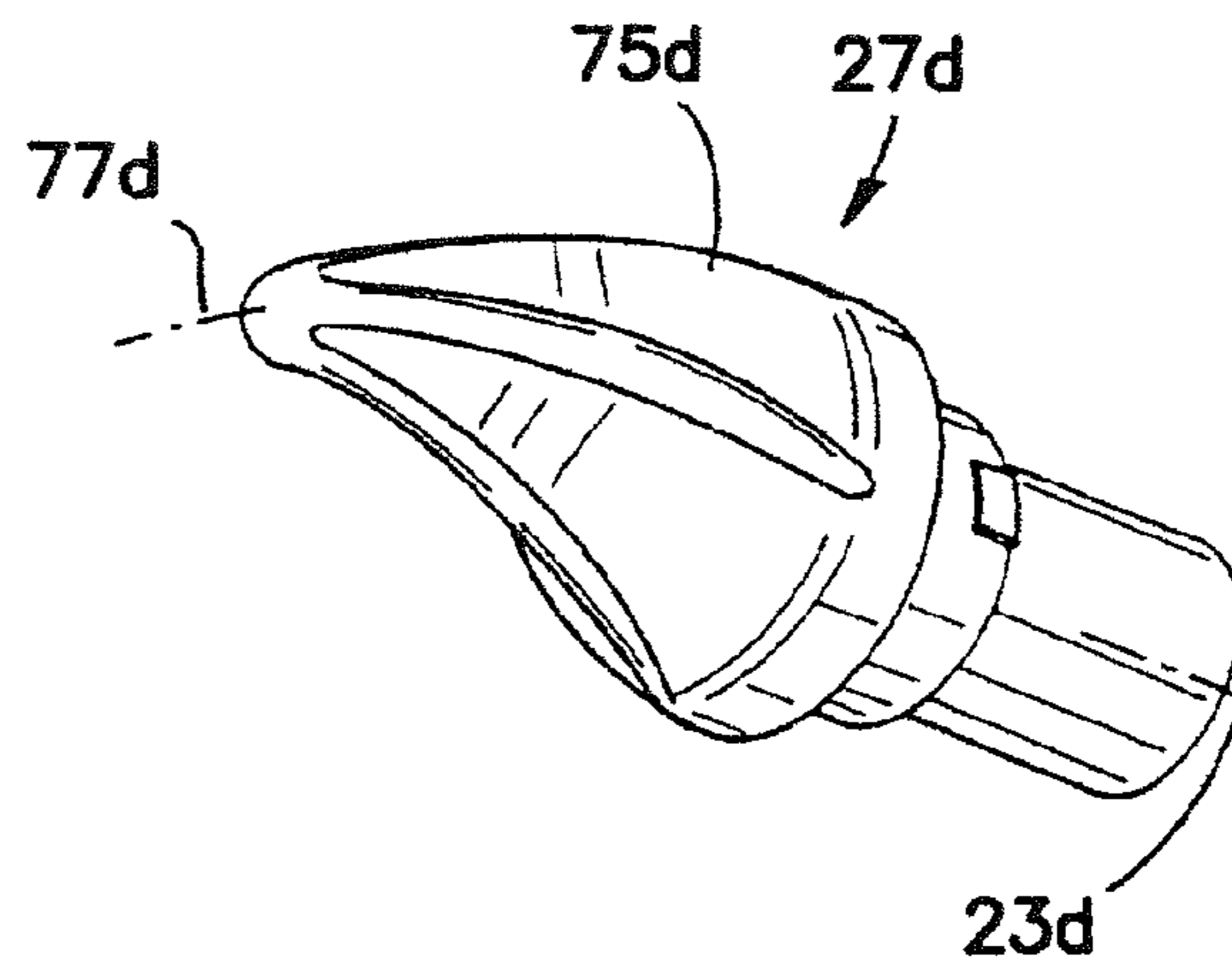


FIG. 16

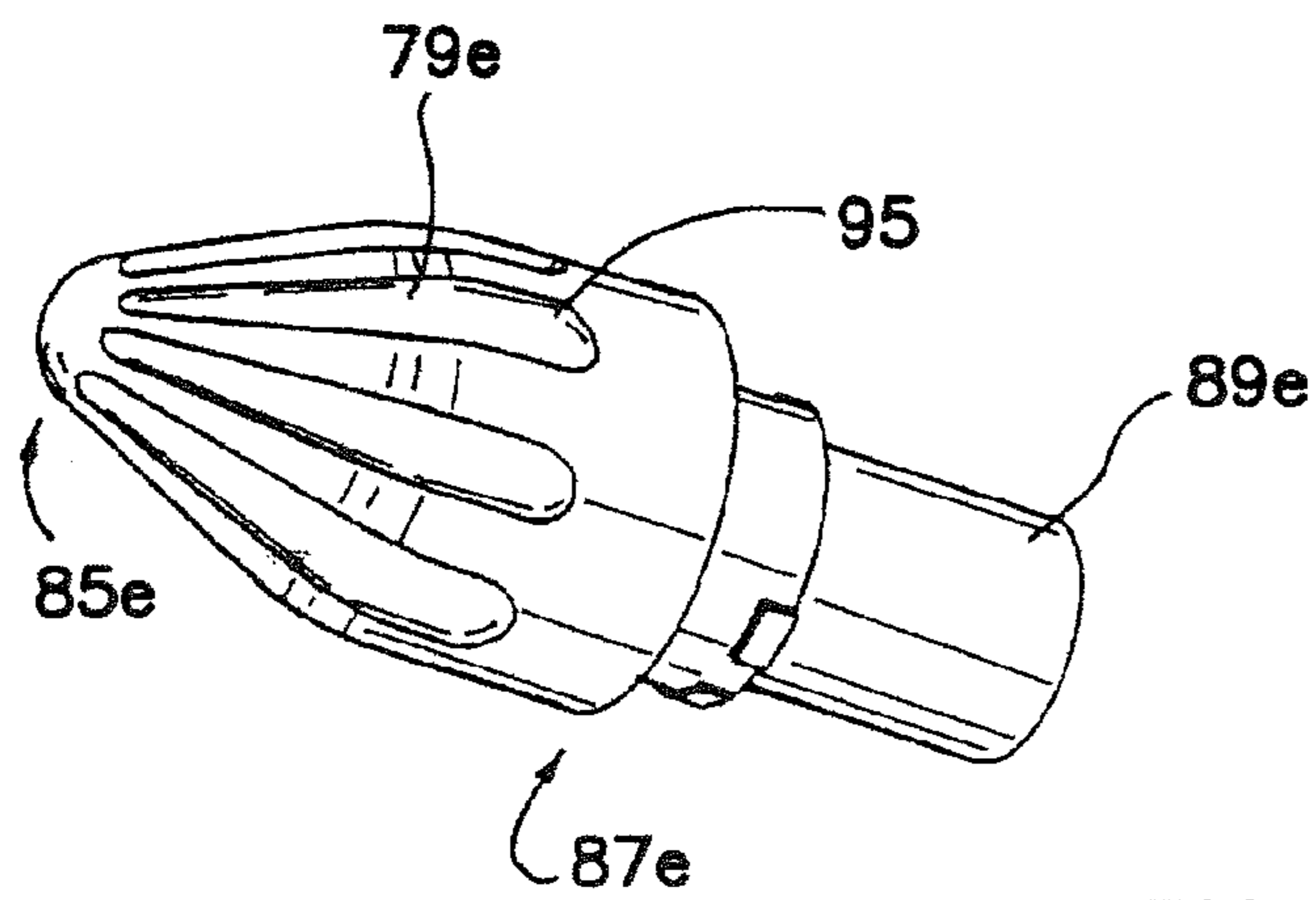
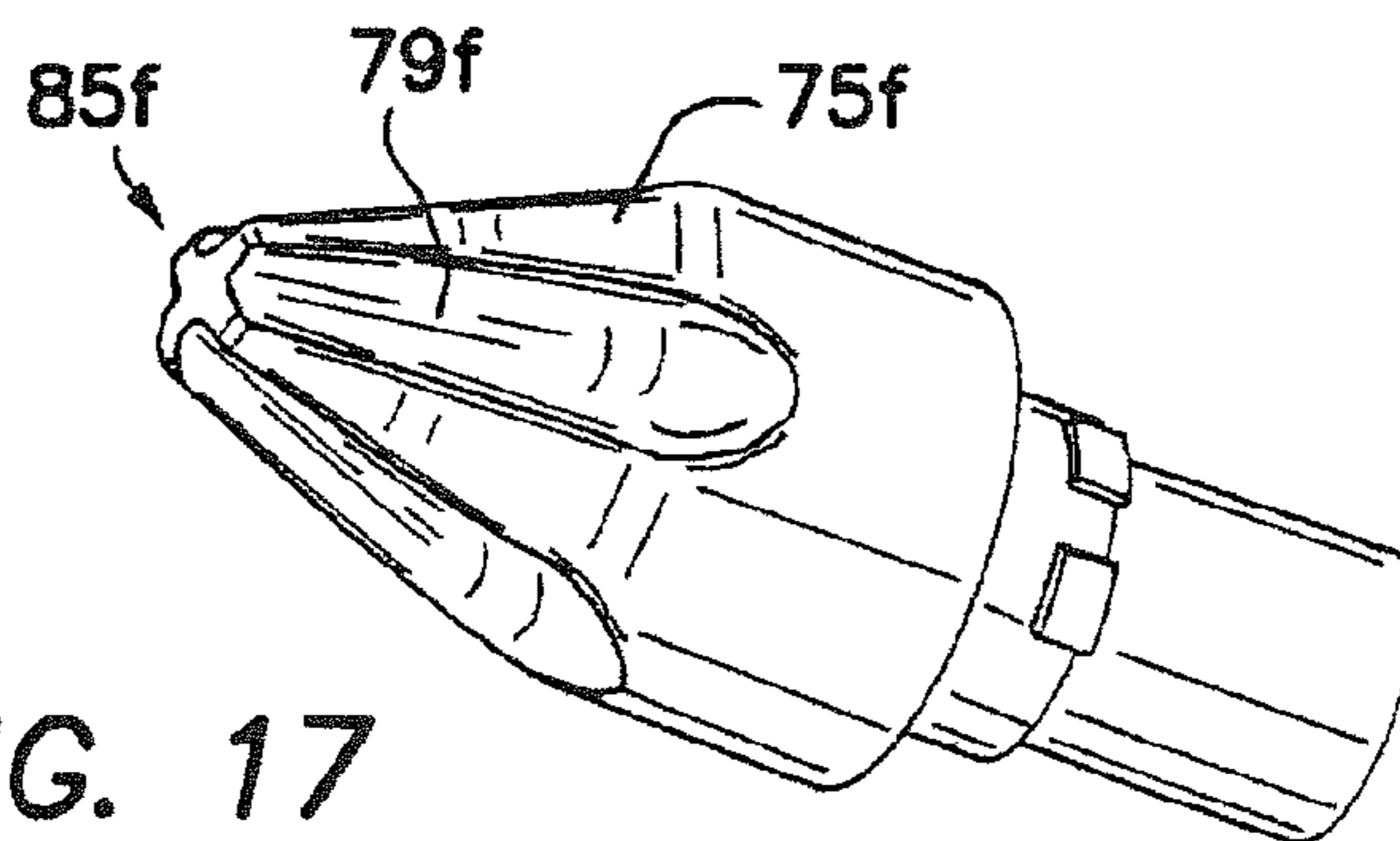


FIG. 17



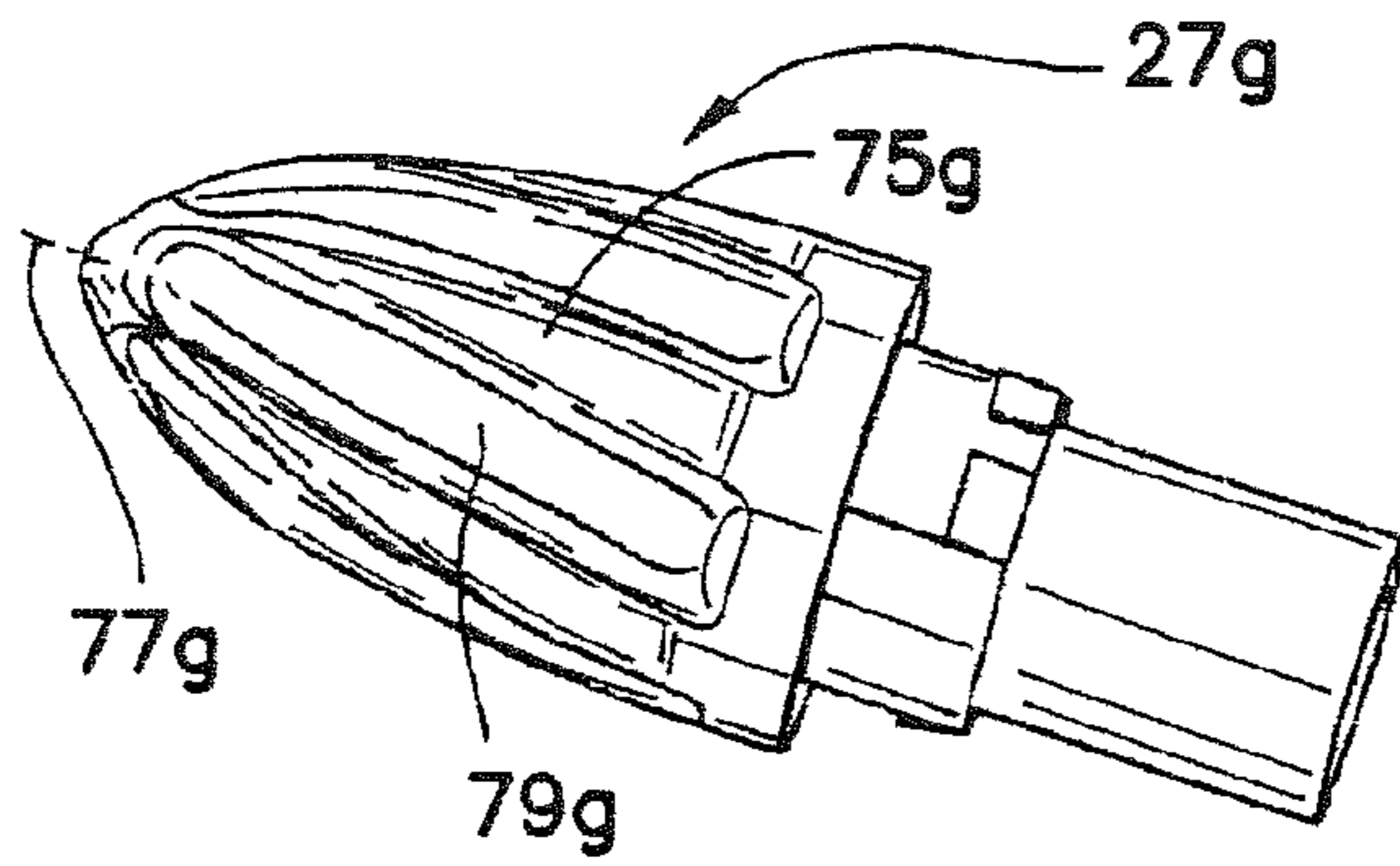


FIG. 18

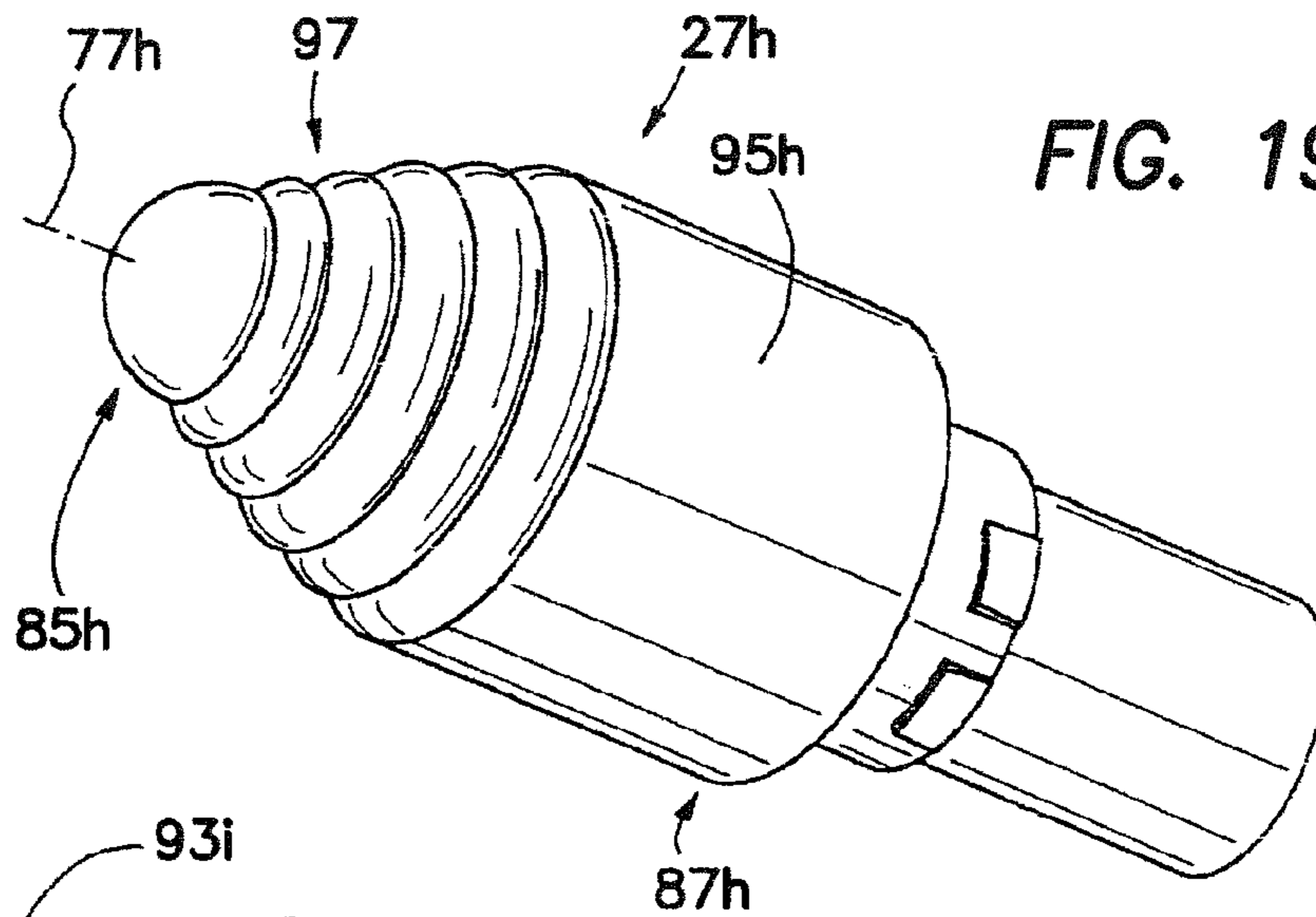


FIG. 19

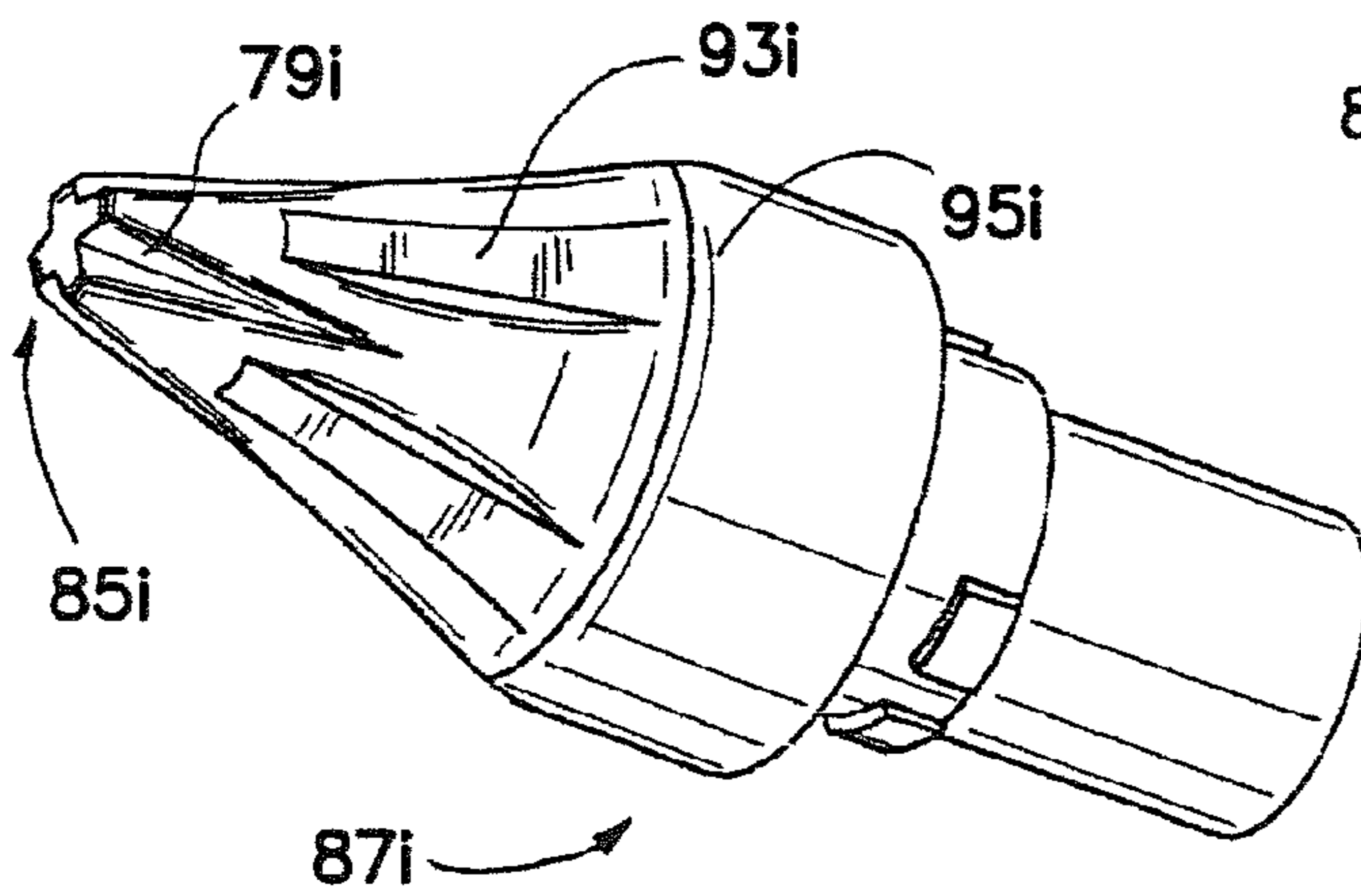


FIG. 20

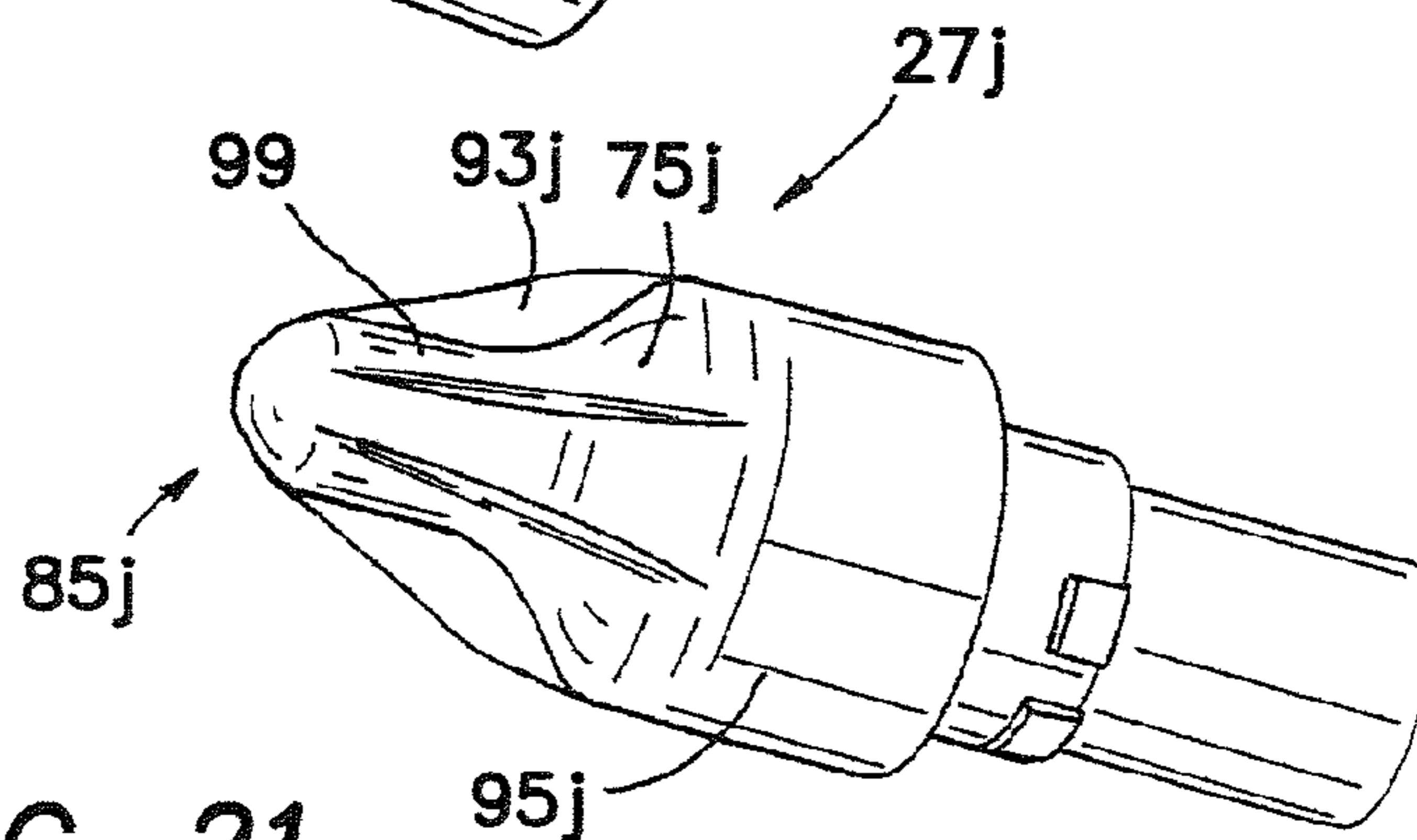


FIG. 21

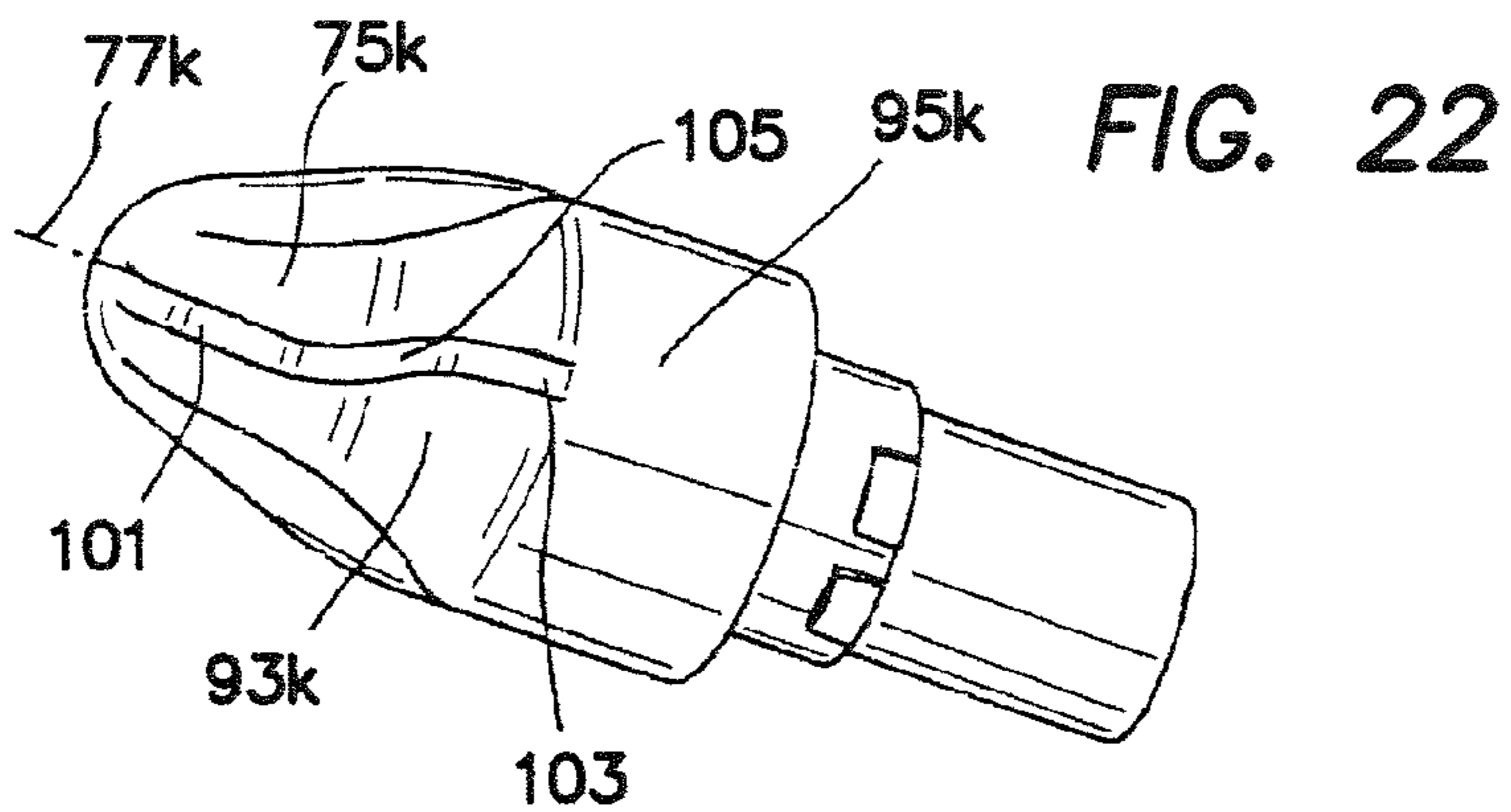


FIG. 24

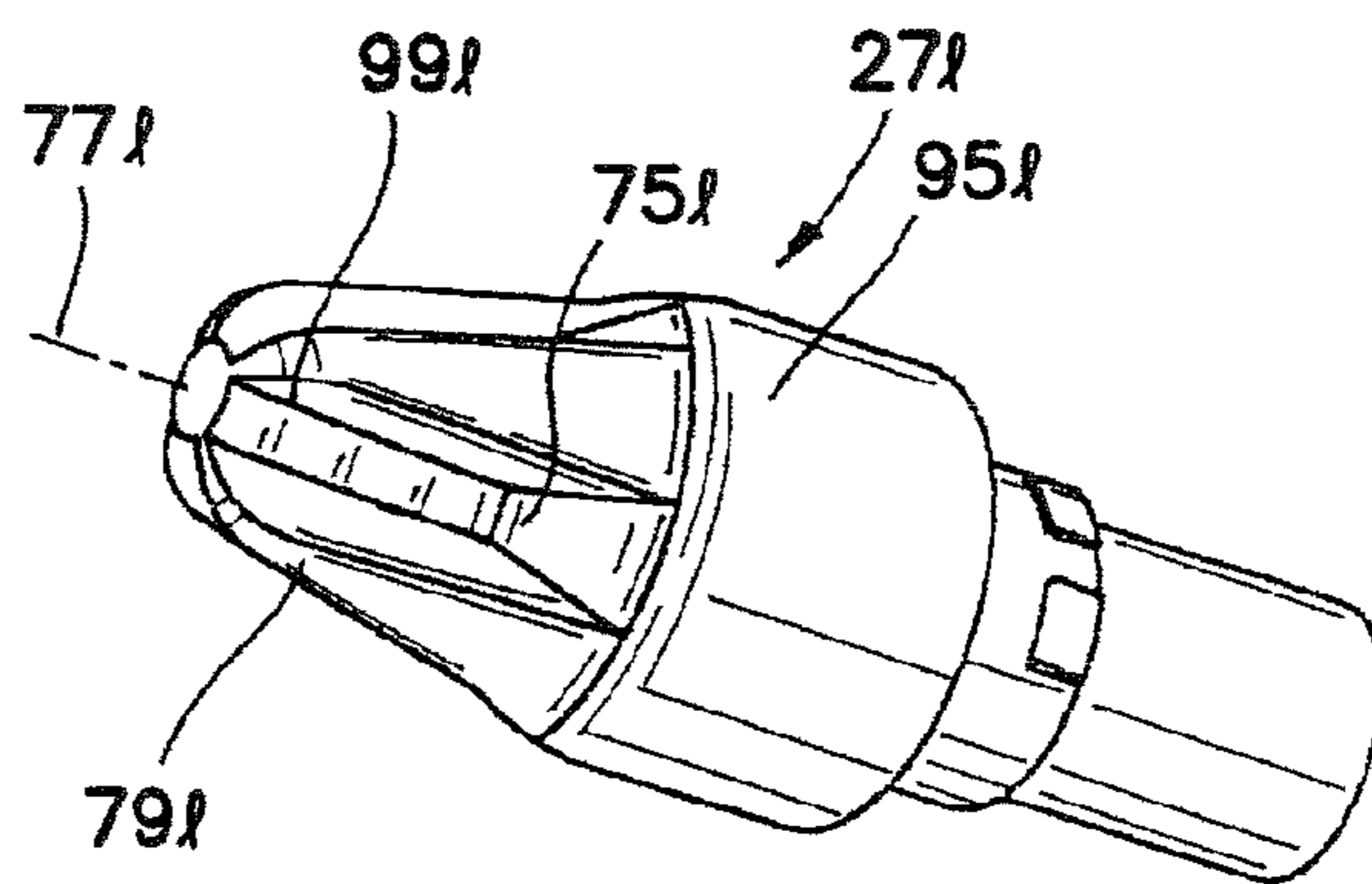
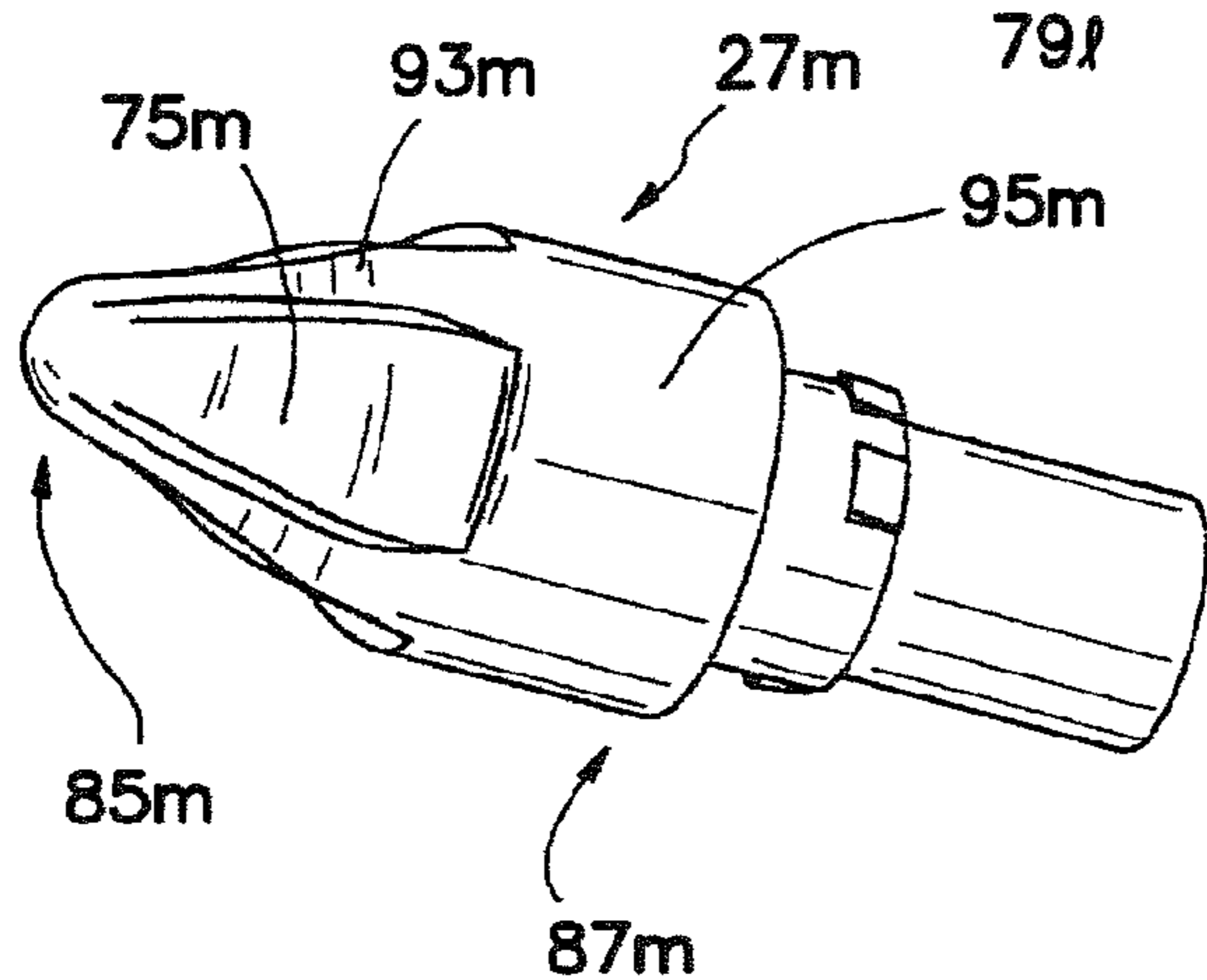
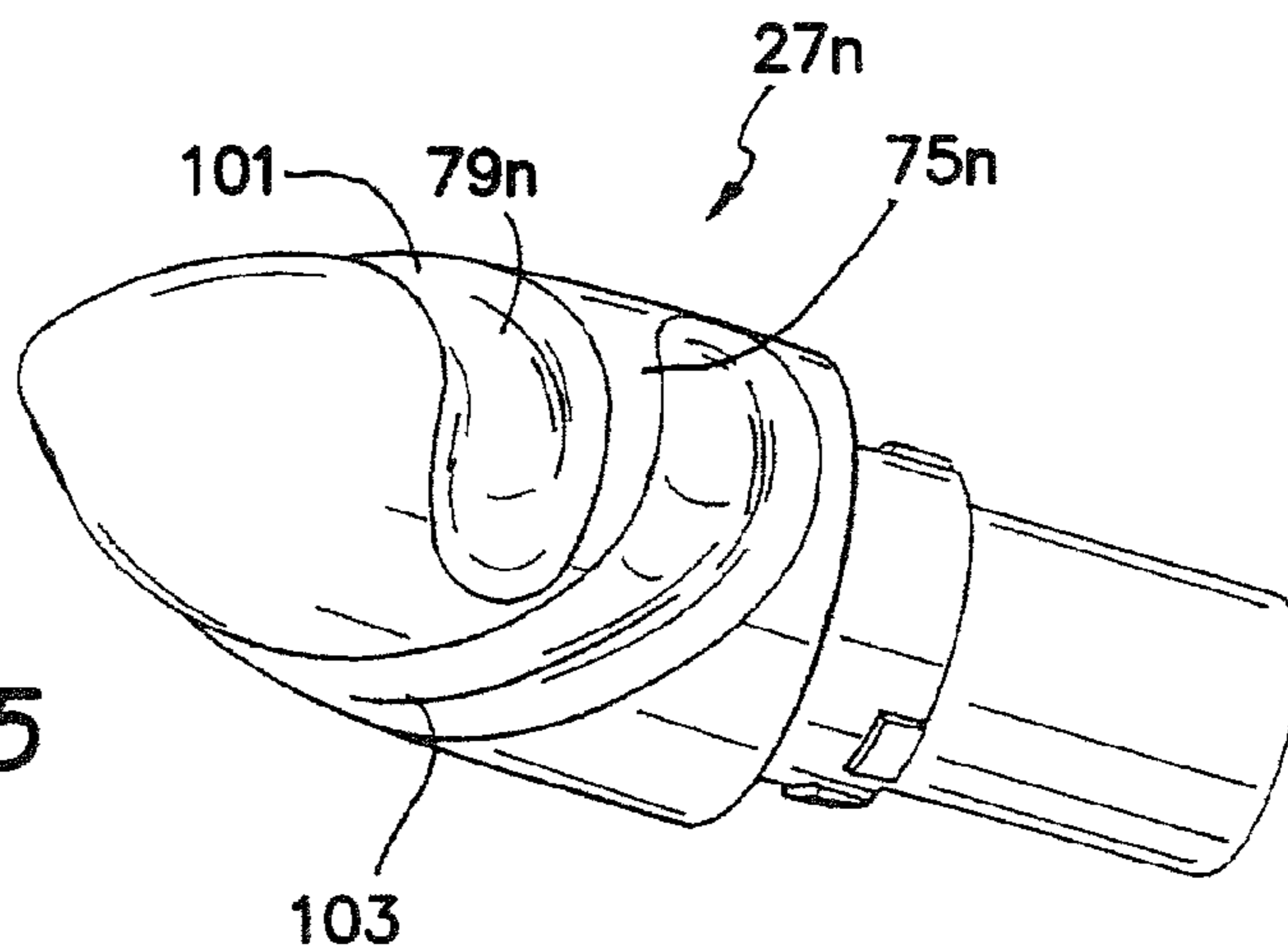


FIG. 23

FIG. 25



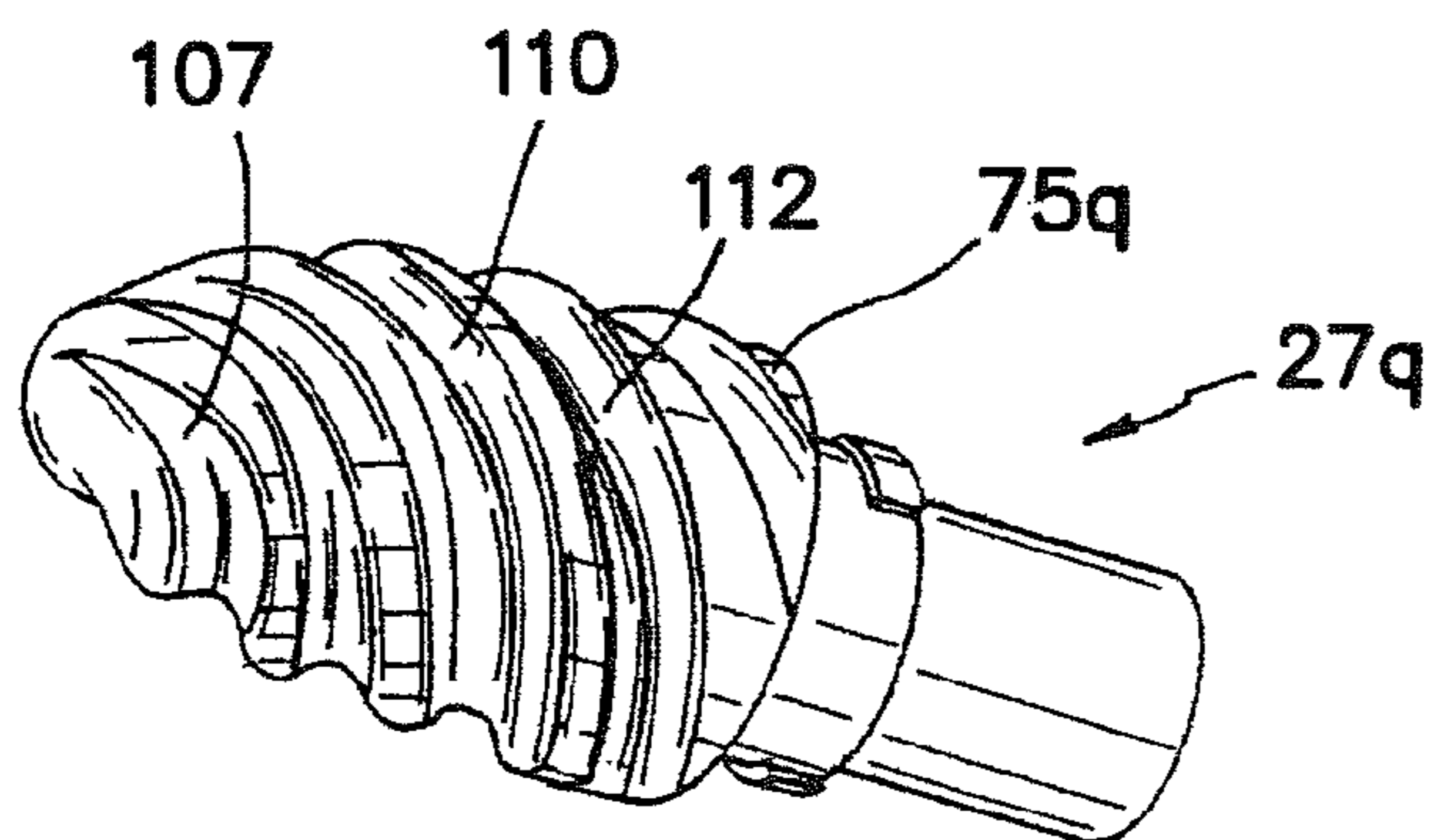
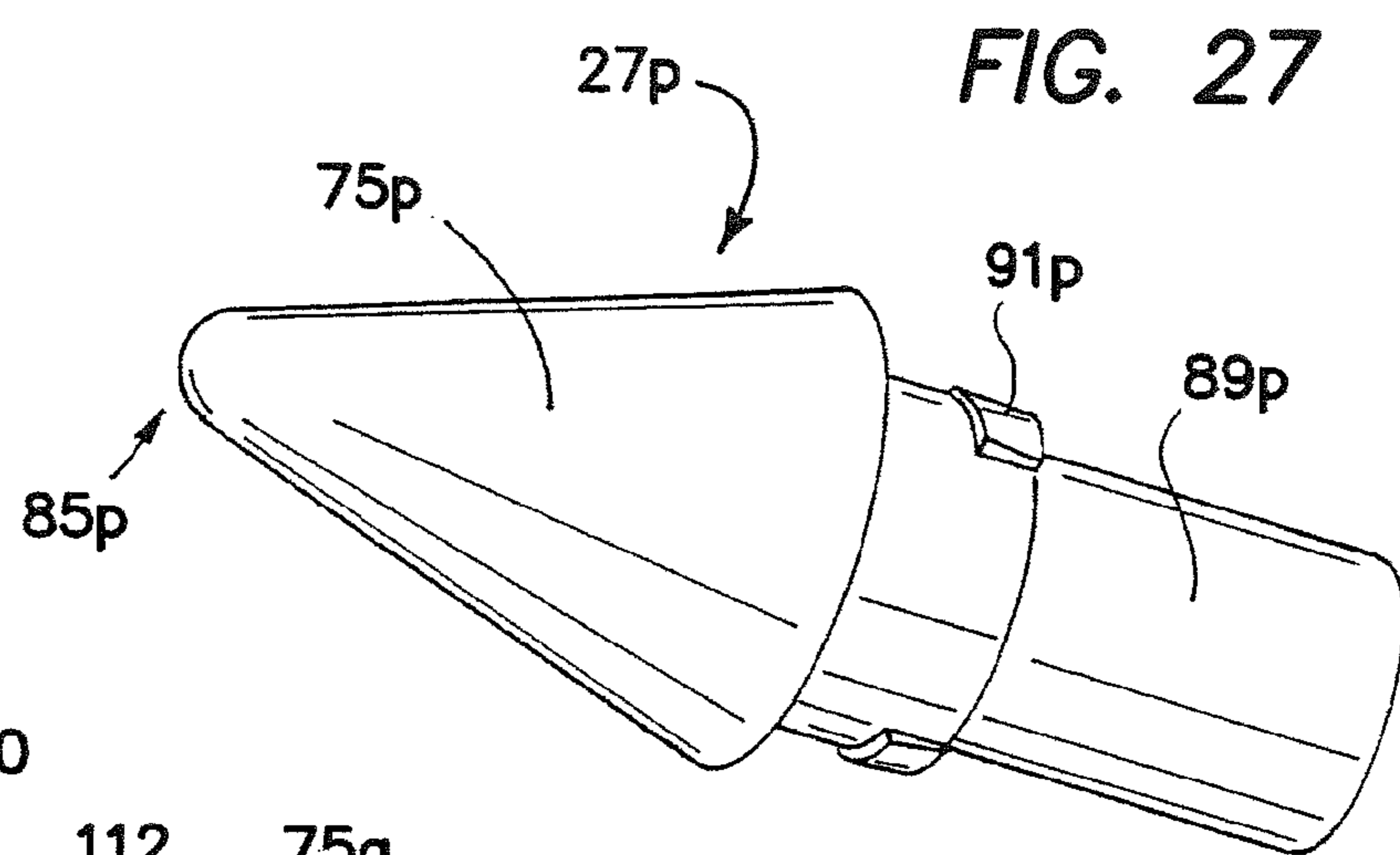
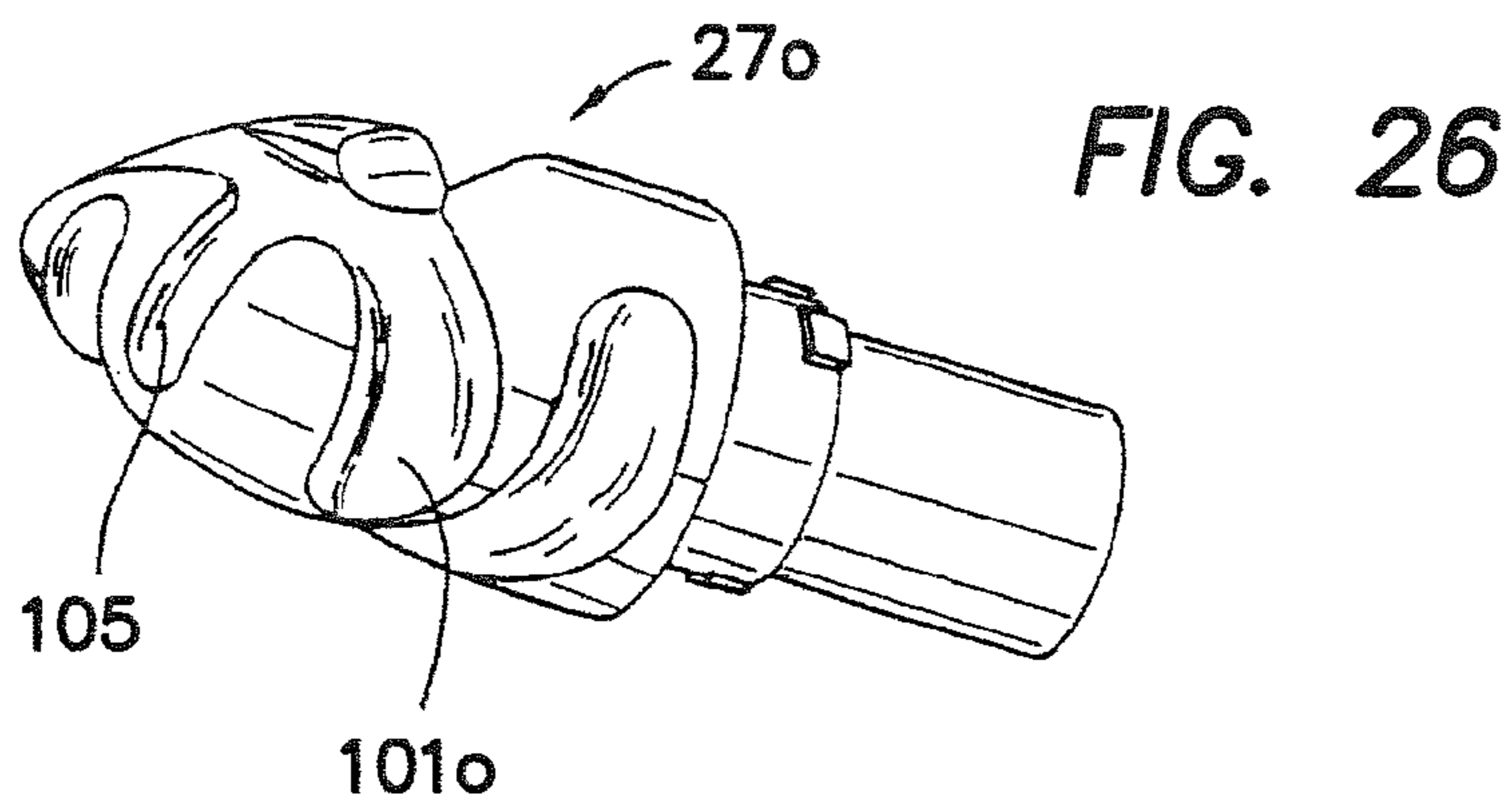
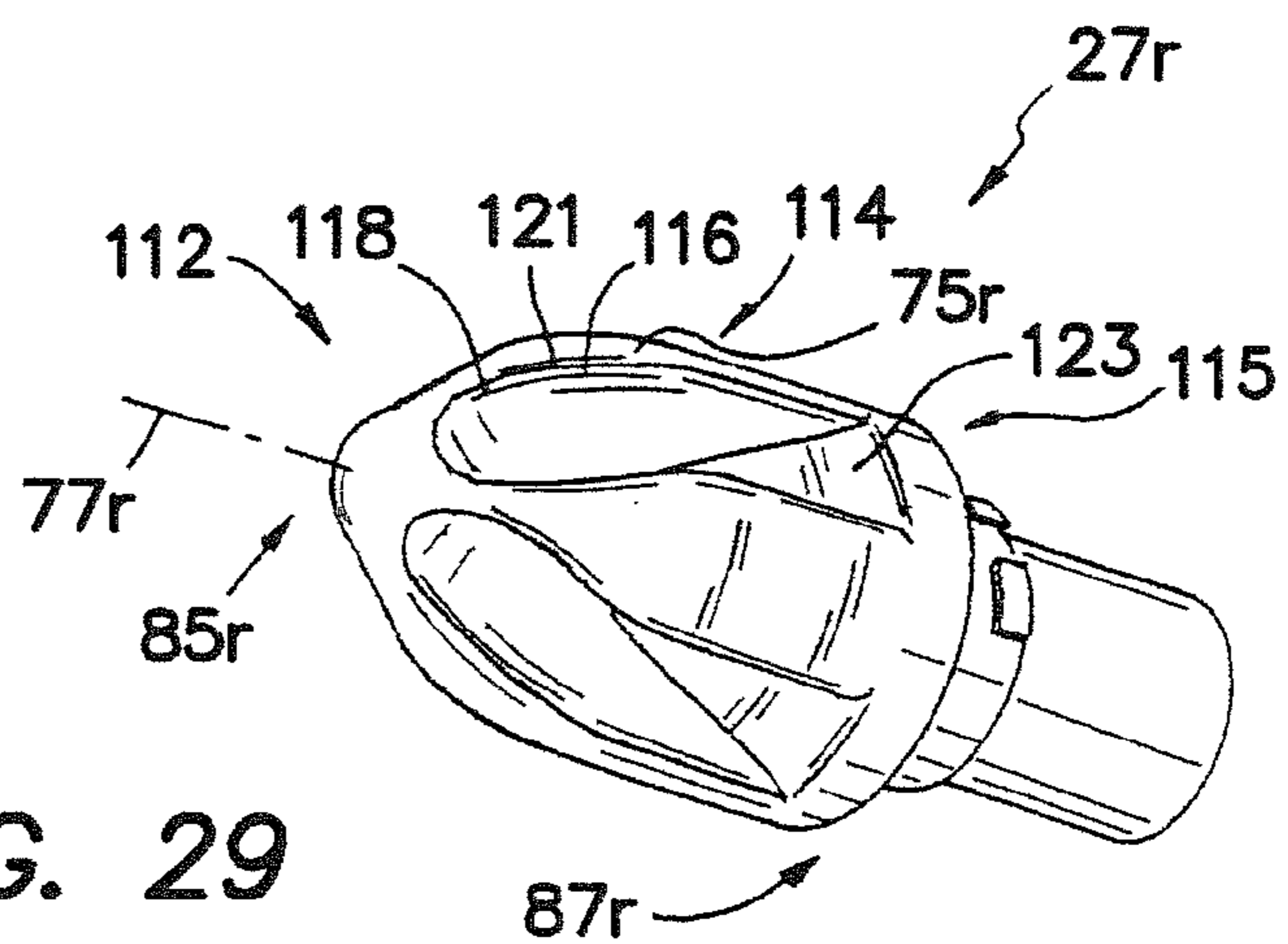
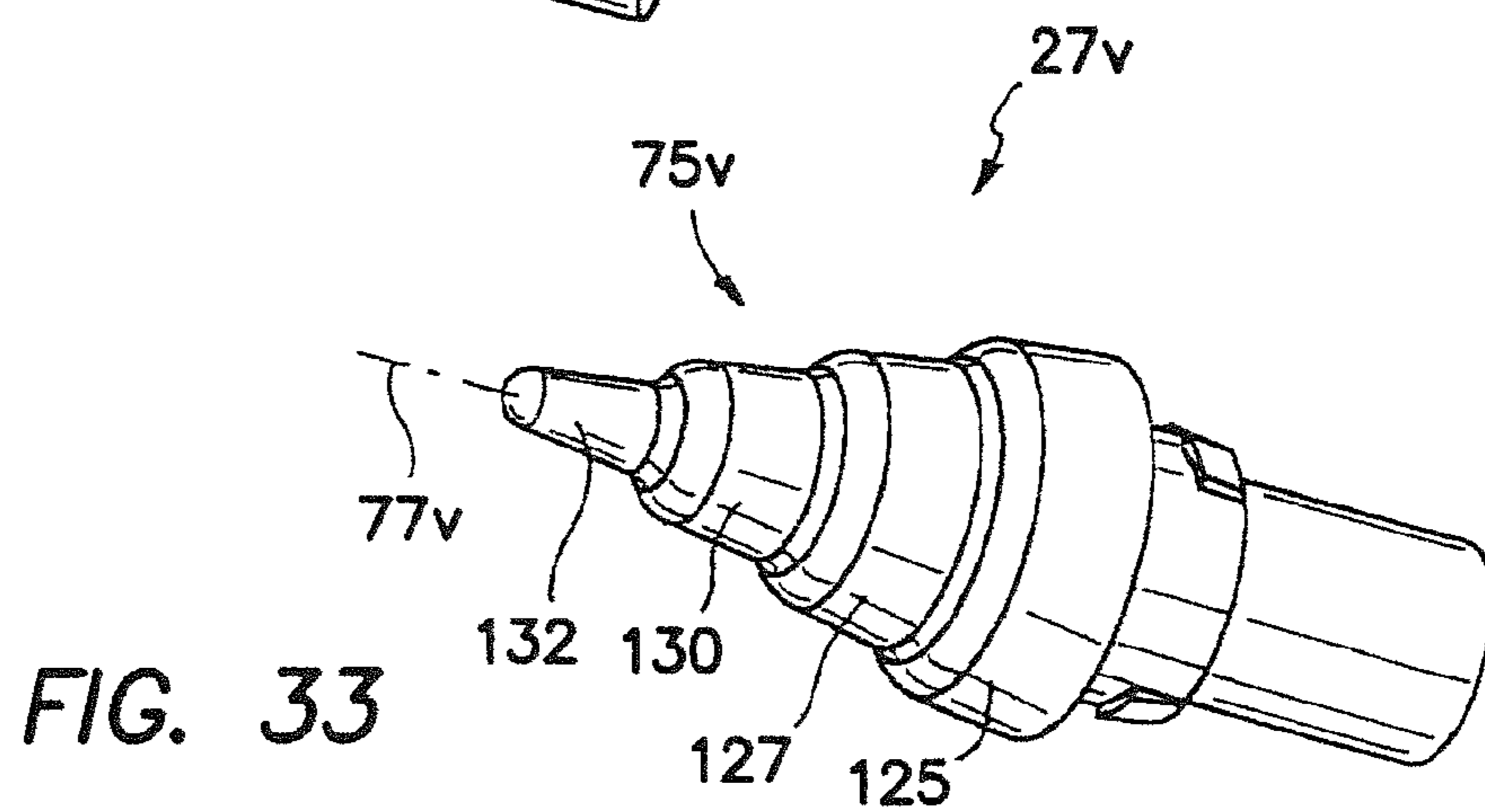
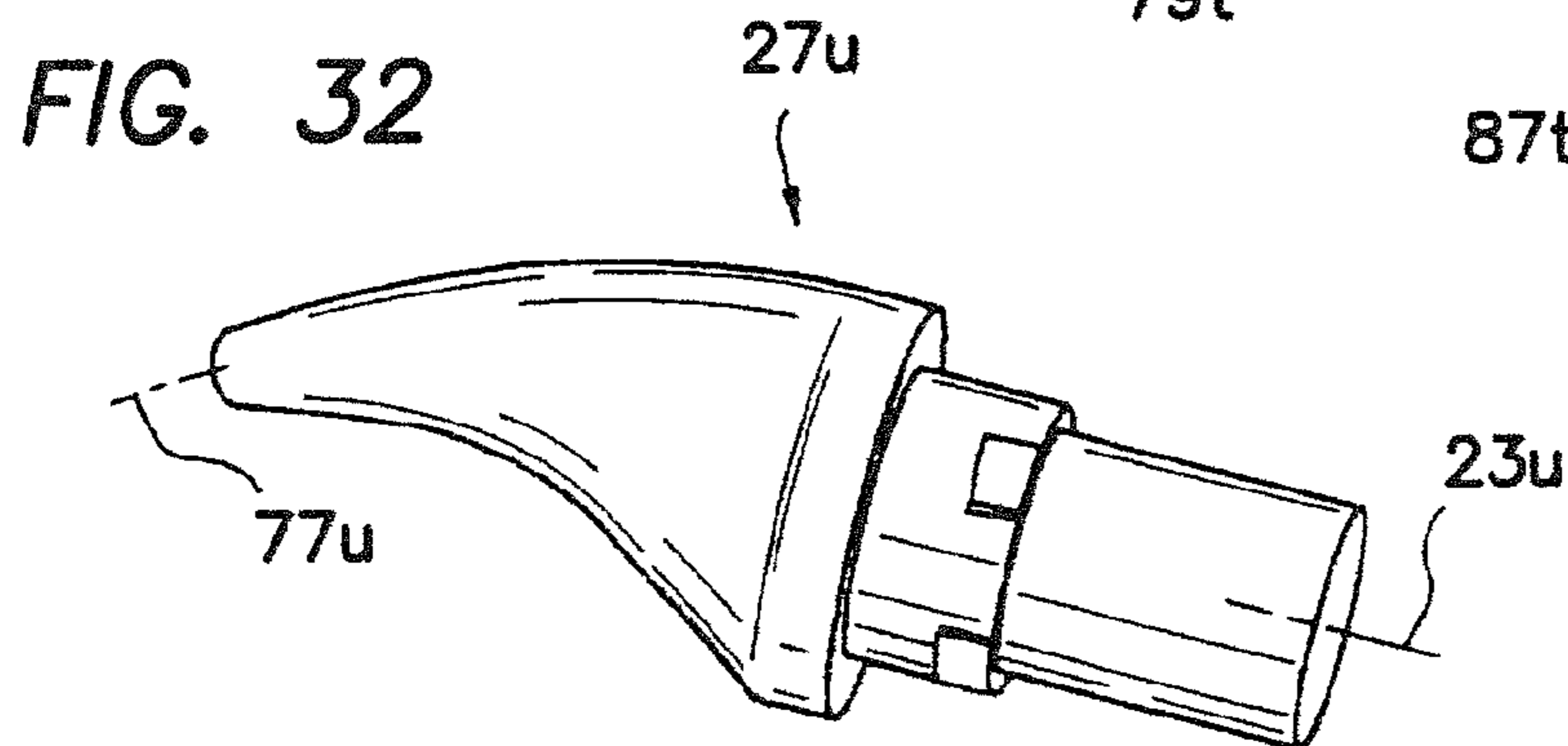
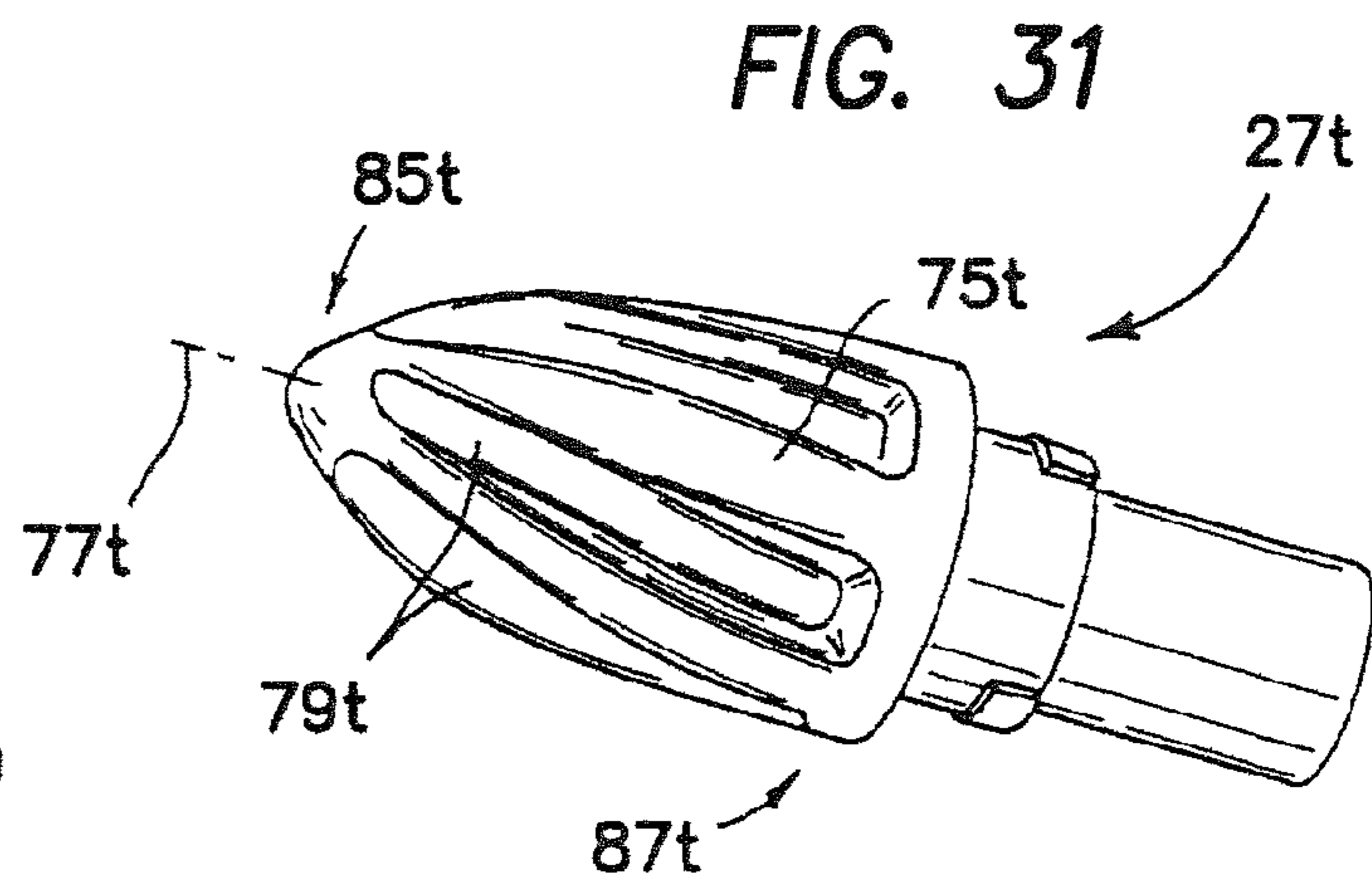
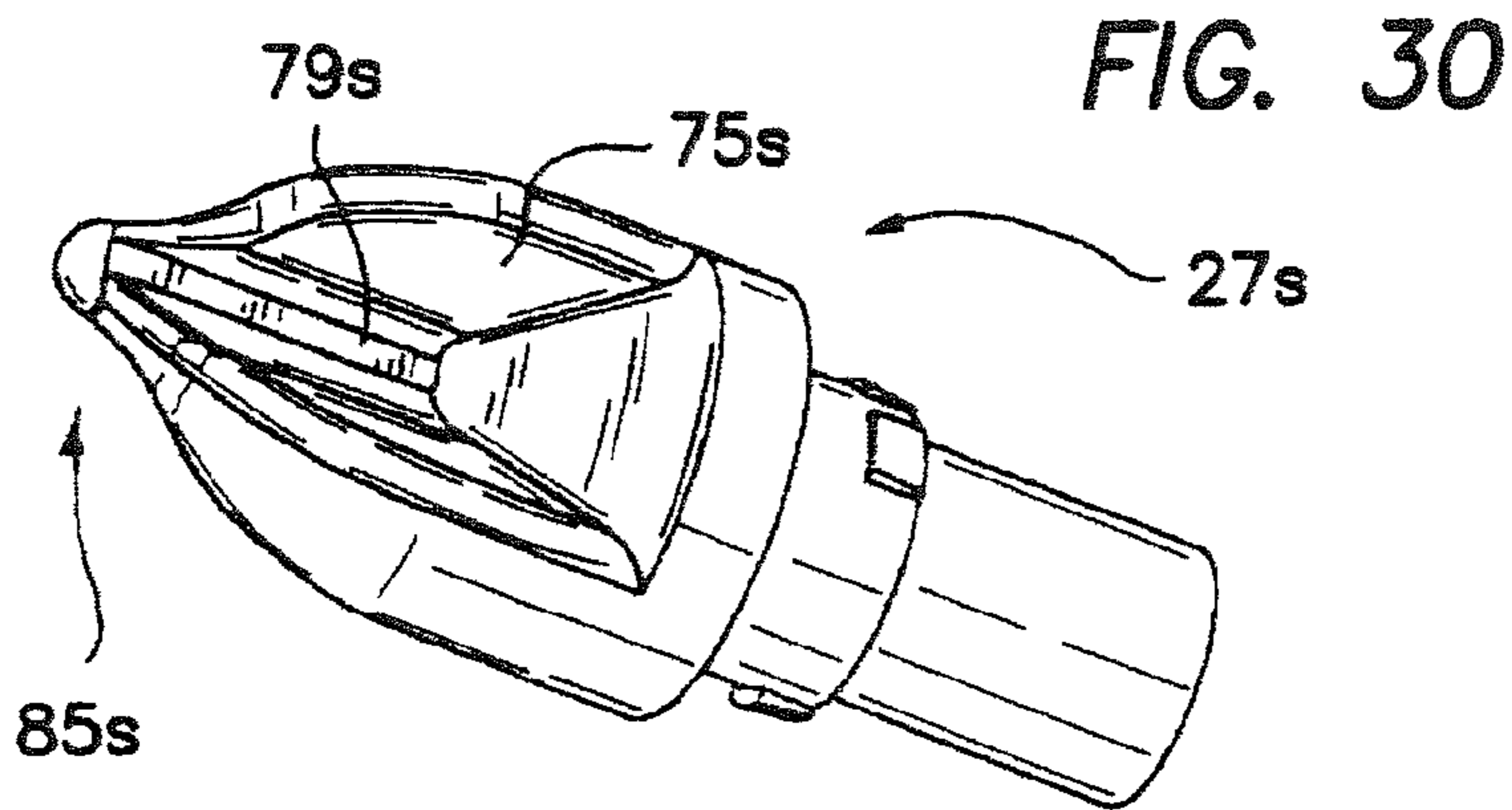
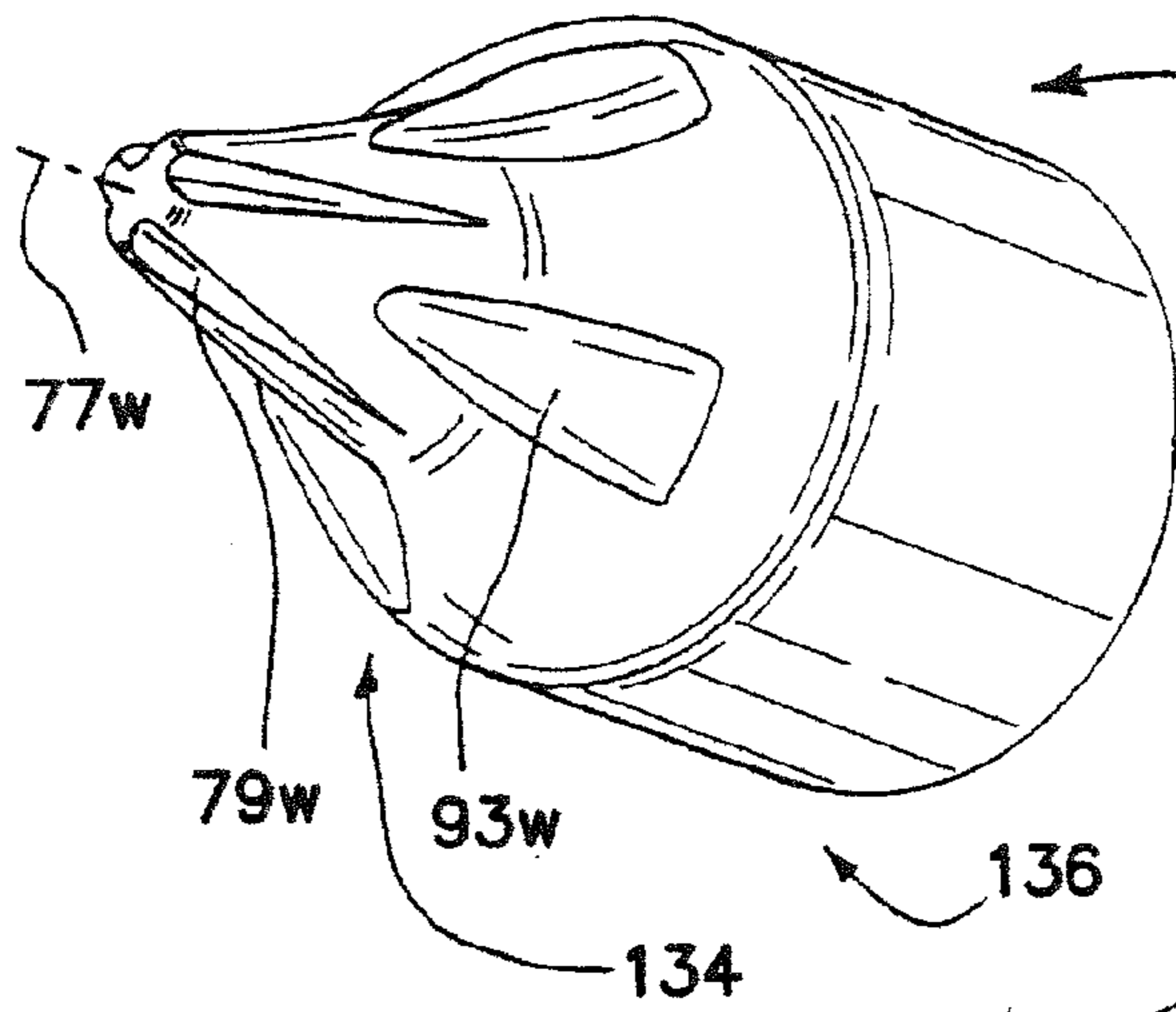


FIG. 28



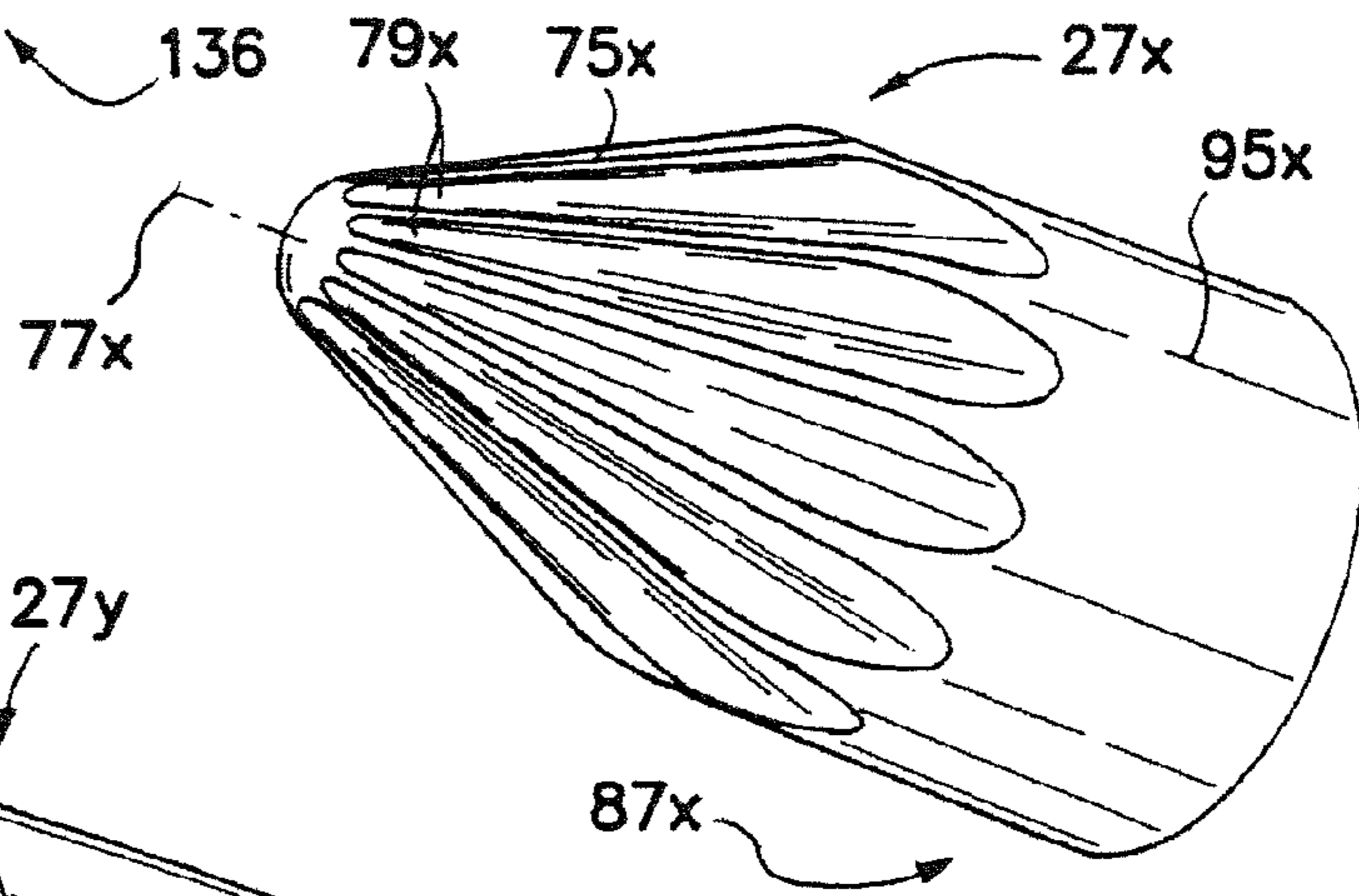




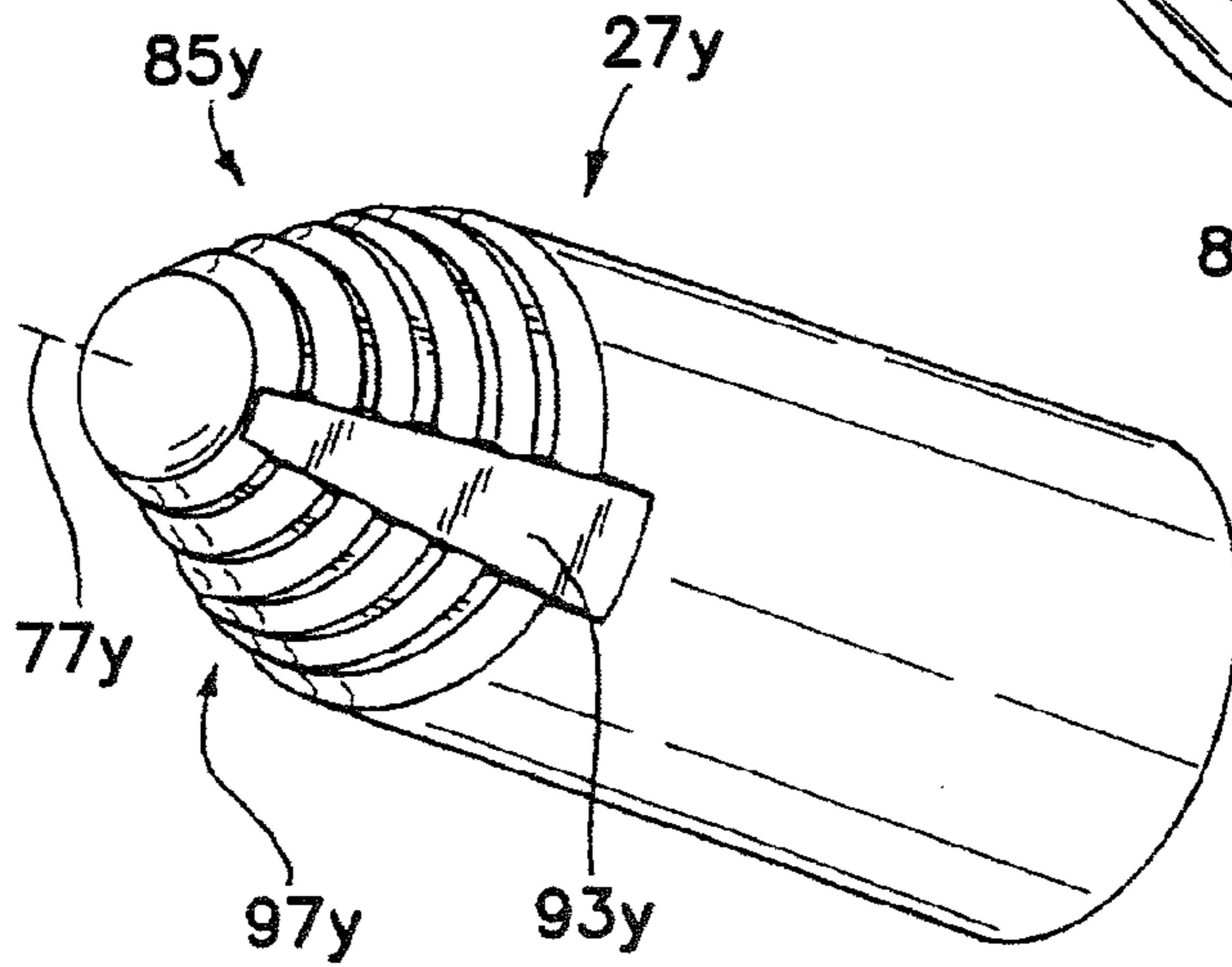
27w

FIG. 34

FIG. 35

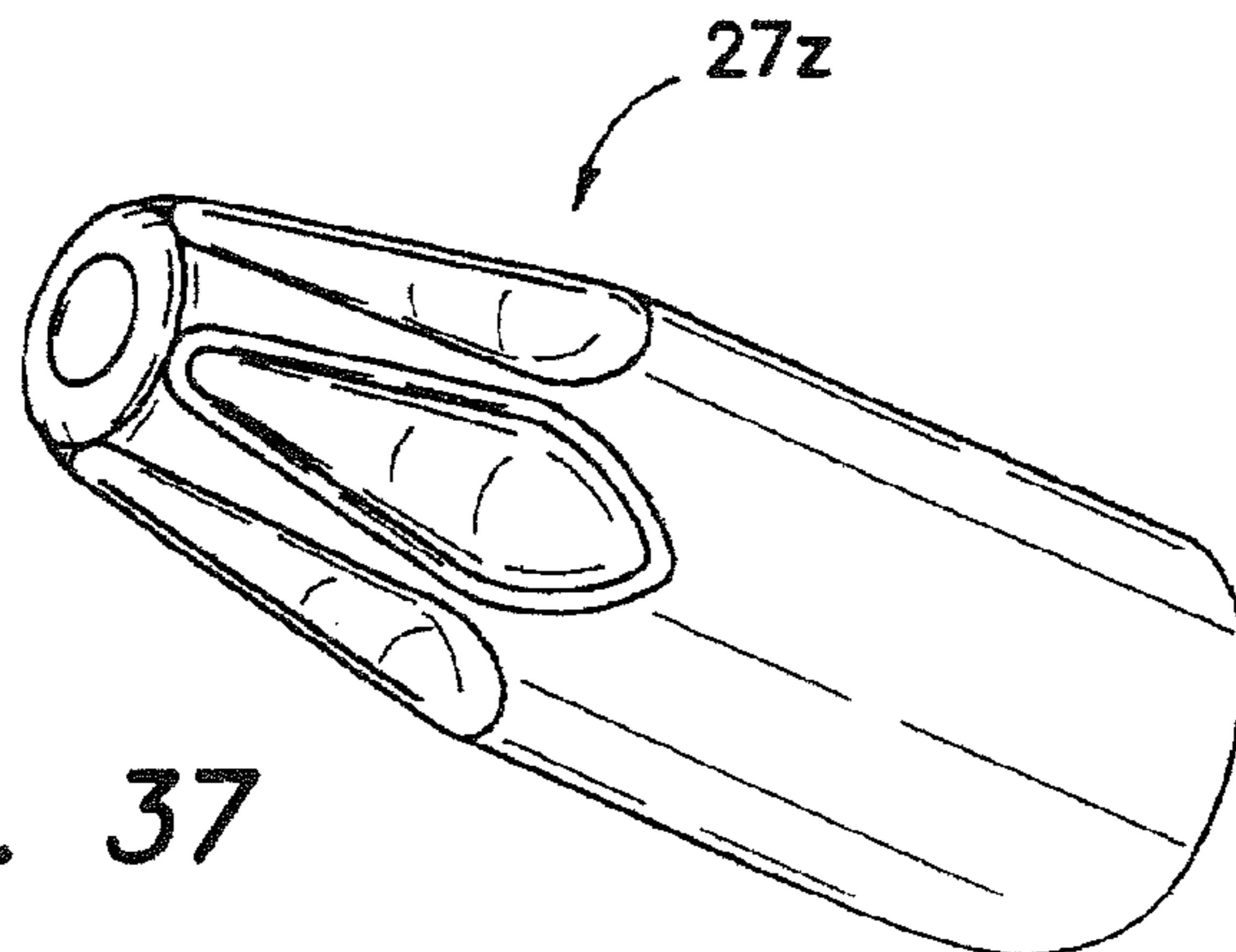


27x



27y

FIG. 36



27z

FIG. 37

BLADELESS OBTURATORCROSS REFERENCE TO RELATED
APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/750,372, filed on Sep. 2, 2010 which is a continuation of U.S. application Ser. No. 10/489,403, now U.S. Pat. No. 7,686,823, which entered the National Phase under 35 U.S.C. §371 on Mar. 11, 2004 from International Application No. PCT/US2002/06759, filed Mar. 4, 2002, which claims the benefit of U.S. Application No. 60/324,613, filed on Sep. 24, 2001, the entire disclosures of which are incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates generally to trocar systems including obturators, and more specifically, bladeless obturators.

BACKGROUND

Trocar systems have been of particular advantage in facilitating less invasive surgery across a body wall and within a body cavity. This is particularly true in the case of the abdominal surgery where trocars have provided working channels across the abdominal wall to facilitate the use of instruments within the abdominal cavity. Particularly in this form of surgery, it is advantageous to insufflate, inflate, or pressurize the abdominal cavity in order to provide an increased working volume. In the interest of maintaining this insufflation, trocars have been provided with valves which form at least two seals: across the working channel a zero seal in the absence of an instrument, and an instrument seal in the presence of an instrument.

The trocar systems of the past typically includes a cannula, which defines the working channel, and an obturator which is used to place the cannula across the abdominal wall. The obturator is inserted into the working channel of the cannula and then pushed through the abdominal wall with a penetration force of sufficient magnitude to result in penetration of the abdominal wall. Once the cannula is in place, the obturator can be removed.

In the past, obturators have been developed with an intent to provide a reduction in the force required for penetration. Sharp blades have typically been used to enable the obturator to cut its way through the abdominal wall. While the blades have facilitated a reduced penetration force, they have been of particular concern once the abdominal wall has been penetrated. Within the abdominal cavity, there are organs which need to be protected against any puncture by an obturator.

In some cases, shields have been provided with the obturators in order to sense penetration of the abdominal wall and immediately shield the sharp blades. These shielding systems have been very complex, have required a large amount of time to deploy, and have generally been ineffective in protecting the organs against the sharp blades.

Blunt-tip obturators have been contemplated with both symmetrical and asymmetrical designs. While the blunt tip tends to inhibit damage to interior organs, it also tends to increase the penetration force associated with the obturator.

In some cases, blunt tip obturators have been adjusted to take advantage of the known anatomy associated with the abdominal wall. This anatomy includes three layers of muscle, each layer having parallel fibers which extend in a particular direction that is different for each of the layers. Notwithstanding this knowledge of the anatomy, prior

attempts to develop blunt-tip obturators have not taken full advantage of this anatomical structure.

SUMMARY

5

In accordance with the present invention, a blunt tip obturator is disclosed with characteristics which take further advantage of the abdominal anatomy. In several embodiments, the obturator has a blunt tip with a blade configuration particularly adapted for alignment parallel to the fibers of the muscle layers. With a twisted configuration, this tip transitions through a rectangular cross section to a circular cross section as it twists radially from a distal end to a proximal end of the tip. This configuration facilitates insertion with a reduced penetration force as the user moves the tip back and forth radially while applying an axial penetration force. With the blade tip having a length to width ratio greater than one, the blade can be inserted between the fibers and then rotated to provide increased fiber separation and thereby facilitate accommodation of the larger diameter associated with the cannula.

In one aspect of the invention, a surgical obturator is adapted to penetrate a body wall. The obturator includes an elongate shaft extending along an axis between a proximal end and a distal end. A bladeless tip is disposed at the distal end of the shaft, the tip having an outer surface extending distally to a blunt point. The outer surface has a pair of side sections separated by an intermediate section. One of the side sections extends from the blunt point radially outwardly with progressive position proximally along the axis. This side section includes a distal portion in proximity to the blunt point and a proximal portion in proximity to the shaft. The distal portion of the one side section is twisted radially with respect to the proximal portion of the one side section. The intermediate section extends across the blunt point of the bladeless tip.

In another aspect of the invention, a bladeless tip is disposed at the distal end of the shaft and has an outer surface with the distal portion and a proximal portion. The outer surface of the tip in radial cross section has the general configuration of a geometric shape with a side. The side of the geometric shape in the distal portion of the tip rotates in the first direction about the axis in progressive proximal radial cross sections along the axis. The side of the geometric shape in the proximal portion of the tip rotates in a second direction opposite to the first direction with progressive proximal radial cross sections along the axis.

In an additional aspect of the invention, the bladeless tip has an outer surface including a pair of generally opposed sections. The outer surface has a geometric shape in progressive radial cross sections from a distal cross section to a proximal cross section. A pair of generally opposed sections of the outer surface appear as a pair of lines in each of the progressive radial cross sections, with at least one of the lines becoming increasingly arcuate in the progressive radial cross sections.

In a further aspect of the invention, the bladeless tip is coupled to the shaft and has an axis extending between a proximal end and a distal end, the tip having an outer surface with a generally conical configuration and a blunt tip. Portions of the outer surface define at least one recess extending relative to the axis generally between the proximal end and the distal end of the tip.

These and other features and advantageous of the invention will become more apparent with a discussion of preferred embodiments in reference to the associated drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a trocar system including a cannula with associated valve housing, and an obturator with a blunt tip extending through the working channel of the cannula to facilitate placement across the abdominal wall;

FIG. 2 is a perspective view of a preferred embodiment of the blunt tip illustrated in FIG. 1;

FIG. 3 is a side elevation view of the blunt tip taken along lines 3-3 of FIG. 2;

FIG. 4 is a side elevation view taken along lines 4-4 of FIG. 3;

FIG. 5 is an end view taken along lines 5-5 of FIG. 4;

FIG. 6 is a radial cross-section view taken along line 6-6 of FIG. 4;

FIG. 7 is a radial cross-section view taken along line 7-7 of FIG. 4;

FIG. 8 is a radial cross section view taken along lines 8-8 of FIG. 4;

FIG. 9 is a radial cross section view taken along lines 9-9 of FIG. 4;

FIG. 10 is a radial cross section view taken along lines 10-10 of FIG. 4;

FIG. 11 is a schematic view illustrating each of the FIGS. 5-10 superimposed to facilitate an understanding of the twisted configuration of the blunt tip; and

FIG. 12-37 show perspective views of other embodiments of the blunt tip of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

A trocar system is illustrated in FIG. 1 and designated by the reference numeral 10. This system includes a cannula 12, defining a working channel 14, and a valve housing 16. The system 10 also includes an obturator 18 having a shaft 21 extending along an axis 23. A handle 25 is disposed at a proximal end of the shaft at 21 while a blunt tip 27 is disposed at a distal end of the shaft 21. The shaft 21 of the obturator 18 is sized and configured for disposition within the working channel 14 of the cannula 12. With this disposition, illustrated in FIG. 1, the obturator functions to penetrate a body wall such as the abdominal wall 30 to provide the cannula with access across the wall 30 and into a body cavity, such as the peritoneal or abdominal cavity 32. The blunt tip 27, which initially facilitates penetration of the abdominal wall 30 can be removed with the obturator 18 once the cannula 12 is operatively disposed with the working channel 14 extending into the abdominal cavity 32.

In order to facilitate penetration of the abdominal wall 30 by the trocar system 10, a penetration force, represented by an arrow 34, is typically applied along the axis 23. It can be appreciated that the force required to penetrate the abdominal wall 30 drops significantly once the wall 30 is penetrated. Further application of the force 34, even for an instant of time, can result in injury to organs within the cavity 32. Where the obturators of the past have included blades facilitating penetration of the abdominal wall, these blades have been particularly threatening and detrimental to the interior organs.

Consequently, in accordance with the present invention, the tip 27 of the obturator 18 is provided with a blunt configuration. As noted, blunt tips have been used in the past to significantly reduce any potential for damage to interior organs. Unfortunately, these blunt tips have increased significantly the amount of force 34 required for penetration of the abdominal wall 30.

The blunt tip 27 of the present invention takes into account an anatomical configuration of the abdominal wall 30 with an improved structural design and method of insertion.

In order to fully appreciate the aspects of this invention, it is helpful to initially discuss the anatomy associated with the abdominal wall 30. This wall 30 typically includes the skin or fascia 35 and a series of muscles in the form of muscle layers 36, 38 and 41. These layers are each defined by muscle fibers which extend generally parallel to each other in a direction which is different for each of the layers. For example, the layer 38 is composed of fibers 43 which extend generally parallel in a particular direction. Fibers 45 associated with the layer 36 extend generally parallel at an angle such as 45 degrees to the particular direction of the fibers 43. Fibers 47 associated with the layer 41 also extend in a parallel direction but at an angle of about 45 degrees to the fibers 43 and an angle of about 90 degrees to the fibers 45.

Having noted the directional nature of the fibers, such as the fibers 45, it can be appreciated that such a structure is most easily penetrated by a tip 27 having a narrow width which is capable of being moved generally parallel to and between the fibers associated with a particular muscle layer. This narrow width might be provided with a point configuration or in the case of a preferred embodiment, a line or rectangular configuration having the narrow width and a longer length. With the length oriented parallel to the fibers of a particular layer a reduced penetration force 34 is required to push the obturator 18 through the particular layer.

Unfortunately, with the fibers 45, 43 and 47 oriented at 45 degrees to each other, proper alignment of the tip 27 for penetration of one layer, such as the layer 36, will not necessarily result in proper alignment for penetration of the next layer, such as the layer 38. For this reason, the rectangular configuration for the tip 27 is twisted slightly so that penetration of the first layer 36 begins to rotate the distal end of the tip 27 into proper orientation for penetration of the next layer 38.

The twisted configuration of the tip 27 also causes the tip 27 to function with the mechanical advantage of a screw thread. With this configuration, a preferred method of placement requires that the user grip the handle 25 of the obturator 18, and twist it about the axis 27. This twisting motion in combination with the screw configuration of the tip 27 converts radial movement into forward movement along the axis 23. Thus, the user applies both a forwardly directed force as well as a radial force to move the trocar system 10 in a forward direction. Since all of the force supplied by the user is not directed axially along the axis 23, this concept avoids the tendency of prior trocar systems to jump forward upon penetration of the wall 30.

The twisted and rectangular configuration of the tip 27 is most apparent in the schematic view of FIG. 2 and the side elevation views of FIGS. 3 and 4. In this embodiment, the tip is composed generally of four surfaces: two opposing major surfaces 50 and 52, separated by two side surfaces 54 and 56 which extend between an end surface 58 and a proximal base 61. A plane drawn through the axis 23 would show the tip 27 in this case, to be composed of two symmetrical halves.

The major surfaces 50 and 52 and the side surfaces 54 and 56 generally define the cross section of the tip 27 to be rectangular from the distal surface 58 to the proximal end 61. This configuration can best be appreciated with reference to the cross section views of FIGS. 5-10. In FIG. 5, the distal end of the tip 27 is shown with a rectangle having the greatest length to width ratio. This rectangle, designated by the reference numeral 63, also has a twisted, S-shaped configuration at the distal-most end of the tip 27.

5

As views are taken along progressive proximal cross sections, it can be seen that the rectangle 63 becomes less twisted, and the width increases relative to the length of the rectangle 63. The spiral nature of the tip 27 is also apparent as the rectangle moves counterclockwise around the axis 23 in the embodiment of FIG. 2. This is perhaps best appreciated in a comparison of the rectangle 63 in FIG. 7 relative to that in FIG. 6. With progressive proximal positions, the rectangle 63 begins to fatten with a reduction in the ratio of length to width. The long sides of the rectangle 63 also tend to become more arcuate as they approach a circular configuration most apparent in FIGS. 9 and 10. In these figures, it will also be apparent that the rotation of the rectangle 63 reaches a most counterclockwise position and then begins to move clockwise. This is best illustrated in FIGS. 8, 9 and 10. This rotation back and forth results from the configuration of the side surfaces 54 and 56, which in general, have a U-shape best illustrated in FIGS. 2 and 3.

The ratio of the length-to-width of the rectangle 63 is dependent on the configuration of the side surfaces 54 and 56, which defined the short sides of the rectangle 63 as well as the configuration of the major surfaces 50 and 52 which define the long sides of the rectangle 63. Again with reference to FIG. 3, it can be seen that the side surfaces 50 and 52 are most narrow at the distal end of the tip 27. As these surfaces extend proximally, they reach a maximum width near the point of the most counterclockwise rotation, shown generally in FIG. 8, and then reduce in width as they approach the proximal end 61. Along this same distal to proximal path, the major surfaces 50 and 52 transition from a generally flat configuration at the distal end to a generally conical configuration at the proximal end 61.

In the progressive views of FIGS. 6-10, the rectangle 63 is further designated with a lower case letter a, b, c, d, or e, respectively. In FIG. 11, the rectangles 63 and 63a-63c are superimposed on the axis 23 to show their relative sizes, shapes, and angular orientations.

A preferred method of operating the trocar system 10 benefits significantly from this preferred shape of the blunt tip 27. With a rectangular configuration at the distal surface 58, the end of the tip 27 appears much like a flathead screwdriver. The length of the surface 58 is aligned parallel with the fibers 45 of the layer 36. With this shape, the simple back and forth twisting motion tends to separate the fibers 45 along natural lines of separation, opening the muscle layer 36 to accept the larger diameter of the cannula 12. By the time the first layer 36 is substantially penetrated, the twisted configuration of the blunt tip 27 turns the rectangle at the distal surface 58 more into a parallel alignment with fibers 43 in the next layer 48. Again, a twisting or dithering motion facilitates an easy separation of these fibers requiring a significantly reduced penetration force along the arrow 34.

When the muscle layer 38 is sufficiently penetrated, the twisted configuration of the tip 27 automatically rotates the rectangular end surface 58 into generally parallel alignment with the fibers 47 of the next layer 41. Again, the natural separation of these fibers 47 together with the unique configuration of the tip 27, accommodates the further penetration of the layer 41 until the cannula 12 is operatively disposed across the wall 30. It will be noted in particular that the fibers 45, 43, and 47 are naturally separated, not cut. This has two advantageous effects: 1) the abdominal wall 30 easily closes upon removal of the trocar system 10; and 2) without cutting, very little bleeding is encountered and very little healing is required to seal the wound permanently.

Certainly, one of the primary purposes of the invention is to maintain control and facilitate entry into the body cavity 32

6

while inhibiting any tearing or cutting of tissue. The tip 27 is bladeless, blunt, and atraumatic to organs and bowel within the peritoneal or abdominal cavity 32. The tip 27 also minimizes tenting of the peritoneum and allows for a safe entry. The device is used in conjunction with the cannula 12 to create an initial entry way into the peritoneal cavity 32. The obturator is first inserted through the valve housing 16 and into the cannula 12. The entire trocar system 10 is then inserted through the abdominal wall 30 and into the peritoneal cavity 32. Once the cannula 12 is properly placed, the obturator 18 can be removed.

This facilitates a unique method of separating tissue and could apply to any object with a slim profile and flat sides. When inserted into the peritoneum the slim profile of the device requires very little area to move safely between tissue and muscle fibers. The device can then be rotated in alternating clockwise and counterclockwise directions while the downward penetration force is applied. When rotated in alternating directions, the tissue is moved apart and a larger opening is created for a profile of greater cross sectional area to follow. This process continues with safety and ease until the device enters the peritoneal cavity 32 and moves to its operative position.

When the cannula 12 is ultimately removed, the size of the opening left in the tissue is minimal. Importantly, this opening is left sealed due to a dilating effect caused by the mere separation of fibers. Note that there are no blades or sharp edges to cut muscle fiber, and thereby prolong the healing process.

In other embodiments, the tip 27 of the obturator can be fabricated of a translucent or clear material, and the handle provided with a passageway along the inside of the tip. With this configuration, a laparoscope can be inserted through the handle of the obturator and through the shaft to the tip. Insertion can then be monitored through the laparoscope, and the clear tip of the obturator, in order to further ensure safe entry.

The obturator 18 can be constructed as a single component or divided into two components such as the shaft 21 and the tip 27. If the obturator 18 is constructed as a single component, it may be constructed of either disposable or reusable materials. If the obturator 18 is constructed as two or more components, each component can be made either disposable or useable as desired for a particular configuration. In a preferred embodiment, the obturator shaft 21 and handle are made of a reusable material, such as a metal or an autoclavable polymer in order to facilitate re-sterilization and reuse of these components. In this embodiment, the tip 27 is made of a material that is not autoclavable and therefore is adapted to be disposable.

The blunt tip 27 can be coated or otherwise constructed from a soft elastomeric material. In such a case, the material could be a solid elastomer or composite elastomer/polymer.

The obturator could also contain a spring-biased shield to cover the tip. On entry the shield could be retracted exposing the tip and then immediately and automatically moved distally back over the tip upon full entry into the peritoneal cavity 32. The action of the shield could also serve as an indicator to the surgeon that safe entry had been achieved. The obturator could be constructed in a manner wherein the tip 27 itself is spring biased and keyed to the shaft. The tip 27 would retract during insertion but would then deploy upon entry into the peritoneal cavity 32. This deployment action could also further serve as an indicator of safe entry.

The shaft 21 of the obturator 18 could be partially or fully flexible. With this configuration, the obturator 18 could be inserted through a passageway containing one or more curves of virtually any shape. A partially or fully flexed obturator 18

could then be used with a flexible cannula **12** allowing greater access to an associated body cavity **32**.

The obturator **18** could also be used as an insufflation needle and provided with a passageway and valve to administer carbon dioxide or other insufflation gas to the peritoneal cavity **32**. The obturator **18** could also be used with an insufflation needle cannula, in which cases removal of the obturator **18** upon entry would allow for rapid insufflation of the peritoneal cavity **32**.

The obturator **18** could also be constructed to permit free spinning of the tip about the axis **23**. This would allow the tip **27** to find its own way through the abdominal wall **30** rather than relying on the user for clockwise and counterclockwise rotation.

Other embodiments of the invention are illustrated in FIG. **12-38** where elements of structure similar to those previously disclosed are designated with the same reference numeral followed by the lower case letters "a" to "z", respectively. Thus, in FIG. **12**, the tip **27** is referred to with the reference numeral **27a** while in FIG. **38**, the tip is referred to with a reference numeral **27z**.

In FIG. **12**, the obturator tip **27a** is formed with a conical surface **75** having an axis **77**. In this embodiment, the axis **77** of the surface **75** is collinear with the axis **23a** of the tip **27a**. A plurality of recesses **79** are formed in the conical surface **75** around the axis **77**. These recesses are formed with side walls **81** which extend radially inwardly to a valley **83**. In this embodiment, the conical surface **75** has an angle with respect to the axis **77** which is greater than an angle between the valley **83** and the axis **77**. As a result, the recesses **79** appear to deepen relative to the surface **75** from a distal end **85** to a proximal end **87** of the tip **27a**. The sidewalls **81** have a generally constant angle with respect to the conical surface **75** and consequently have an increased area toward the proximal end **87**. The valley **83** has a generally constant width as it extends towards the proximal end **87**.

In this embodiment, the tip **27a** also has a cylindrical mounting shaft **89** with mounting lugs **91**. This mounting shaft **89** is adapted to closely fit within the obturator shaft **21** (FIG. **1**). The mounting lugs **91** can engage holes or shoulders within the shaft **21** to facilitate a fixed but removable relationship between the shaft **21** and tip **27a**.

In FIG. **13**, the tip **27b** is also characterized by the conical surface **75b**, the cylindrical mounting stub **89** and the lugs **91b**. In this case, the tip **27b** is provided with ridges **93** which extend radially outwardly from the conical surface **75b**. The ridges **93** can have a constant width or a width which increases proximally as in the illustrated embodiment. The height of the ridges above the conical surface **75b** can be either constant or variable between the distal end **85b** and the proximal end **87b**.

The obturator tip **27c** in FIG. **14** is similar to that of FIG. **13** except that the ridges **93c** are not straight but rather curved as they extend between the distal end **85c** and the proximal end **87c**. In this case, the ridges have an angle with respect to the axis **77c** which increases proximally both radially and axially.

The obturator tip **27d** in FIG. **15** is similar to that of FIG. **12** except that the axis **77d** of the conical surface **75d** is curved rather than straight. Accordingly, the axis **77d** of the conical surface **75d** is curved relative to the axis **23d** of the obturator shaft **21d**.

The obturator tip **27e** in FIG. **16** is similar to that of FIG. **12** in that it includes the recess **79e** which extend from the distal end **85e** to the proximal end **87e**. In this case however, the tip **27e** has a cylindrical surface **95** which extends proximally of the conical surface **75e** between the distal tip **85e** and the

mounting stub **89e**. The recesses **79e** in this embodiment extend along both the conical surface **75e** and the cylindrical surface **95**.

The obturator tip **27f** of FIG. **17** is similar to that of FIG. **16** except that the recesses **79f** extend through the distal end **85f**. In the illustrated embodiment, four of the recesses **79f** provide the distal end **85f** with the shape of the letter "X."

The obturator tip **27g** in FIG. **18** is similar to that of FIG. **12** except that the surface **75g** is more rounded thereby providing the tip **27g** with a parabolic or bullet shape. Also, the recesses **79g** are disposed at an angle with respect to any plane passing through the axis **77g**.

The obturator tip **27h** in FIG. **19** has the cylindrical surface **95h** at its proximal end **87h** and a series of grooves **97** which extend circumferentially of the axis **77h** with diameters which increase from the distal end **85h** to the cylindrical surface **95h**. Each of the recesses or ridges in the series **97h** is disposed in an associated plane that is perpendicular to the axis **77h**.

In the embodiment of FIG. **20**, the tip **27i** includes recesses **79i** which are similar to those illustrated in FIG. **17** in that they extend through the distal end **85i**. This embodiment also includes the ridges **93i** which are disposed between the recesses **79i** and extend toward the cylindrical surface **95i** at the proximal end **87i**. The recesses **79i** in FIG. **20** have individual widths which decrease proximally.

In the embodiment of FIG. **21**, the tip **27j** includes the conical surface **75j** which transitions proximally into the cylindrical surface **95j**. Distally of the conical surface **75j** a second cylindrical surface **99j** is provided which extends to the distal end **85j**. Ridges **93j** extend radially outwardly from the second surface **99** and the conical surface **75j**.

The obturator tip **27k** in FIG. **22** is similar to previous embodiments having the conical surface **75k** and the cylindrical surface **95k**. In this embodiment, the ridges **93k** include distally portions **101** and proximal portions **103** which extend in planes passing through the axis **77k**. Between the proximal portions **103** and distal portions **101**, the ridges **93k** include intermediate portions **105** which extend in planes that do not include the axis **77k**.

In FIG. **23**, the tip **27l** is similar to that of FIG. **17** except that the second cylindrical surface **99l** is provided in this embodiment. The recesses **79l** have a generally constant width along the second cylindrical surface **99l** and the conical surface **75l**. These recesses **79l** do not extend into the cylindrical surface **95l**.

The obturator tip **27m** in FIG. **24** is similar to that of FIG. **21** except that it does not include the second cylindrical surface **99m**. In this case, the conical surface **75m** extends to the distal end **85m** with a slightly concave shape. The ridges **93m** transition into the surface **75m** at the distal end **85m** and transition into the cylindrical surface **95m** at the proximal end **87m**. Between these two ends, the ridges **93m** have a height which is increased by the concave configuration of the surface **75m**.

The tip **27n** in FIG. **25** is similar to the tip **27g** in FIG. **18** in that the outer surface **75n** has a generally bullet-shaped configuration. The recesses **79n** include a recess **101** which curves proximally in a counterclockwise direction, and a recess **103** which curves proximally in a clockwise direction.

The tip **27o** in FIG. **26** is similar to that of FIG. **25** but includes a further recess **105** which spirals toward the distal end **85o** in a clockwise direction. This spiral recess **105** crosses the recess **101** in this embodiment.

In FIG. **27**, the tip **27p** includes the conical surface **75p** which extends toward the distal end **85p** at its apex. The apex

of the conical surface **75p** is blunted at the distal end **85p**. This embodiment also includes the mounting stub **89p** and associated lugs **91p**.

The tip **27q** in FIG. **28** has the outer surface **75q** with a bullet-shaped configuration. The recesses **79q** in this embodiment include three recesses, **107**, **110**, and **112** which spiral in a generally parallel relationship proximally in a counter-clockwise direction.

The tip **27r** in FIG. **29** has an outer surface **75r** with a bullet-shaped configuration, and a plurality of recesses **79r** which extend generally axially from the distal end **85** as to the proximal end **87r**. The recesses **79r** are generally symmetrical and include a distal portion **114** with sidewalls **116** and **118** which define a deep valley **121** that extends generally parallel to the axis **27r**. The proximal portion **115** of the recess **112** comprises a plane **123** which extends between the sidewalls **118** and **121** from the valley **116** radially outwardly with progressive positions toward the proximal end **87r**.

The tip **27s** in FIG. **30** is similar to that of FIG. **29**, but includes fewer recesses **79s**. Also, the tip **27s** has a nose that is more pointed thereby providing the outer surface **75s** with a concave configuration near the distal end **85s**.

FIG. **31** shows a perspective view of the tip **27t** with a bullet-shaped outer surface **75t** and a plurality of the recesses **79t**. In this case the recesses are straight but nevertheless have an angular relationship with the axis **77t**. These recesses **79t** extend through the distal end **85t** but stop short of the proximal end **87t**.

The tip **27u** in FIG. **32** is similar to that of FIG. **15** in that the axis **77u** is curved relative to the axis **23u** which is straight. Also, in this embodiment, there are no ridges or recesses.

In FIG. **33**, the tip **27v** has an outer surface **75v** which is formed by individual conical portions **125**, **127**, **130**, and **132**, which have progressively smaller average diameters. These conical portions **125-132** appear to be stacked with their individual axes disposed along the common axis **77v**.

The tip **27w** in FIG. **34** is similar to that of FIG. **20** in that it includes both the recesses **79w**, as well as the ridges **93w**. In this embodiment, which includes both a distal portion **134**, as well as a proximal portion **136**. These portions **124** and **136** have a generally common dimension along the axis **77w**.

The tip **27x** in FIG. **35** includes the conical surface **75x** as well as the cylindrical surface **95x**. The recesses **79x** are oriented generally in respective radial plans. These recesses **79x** are similar in shape and have a width which increases toward the distal end **87x**.

The tip **27y** in FIG. **36** is similar to that of FIG. **19**. It includes concentric circular structures at the distal end **85y**. In this case however, the structures are a series of recesses **97y** rather than ridges. This embodiment includes at least one ridge **93y**, however, which extends radially outwardly with progressive proximal positions along the axis **77y**.

The tip **27z** in FIG. **37** is similar to that of FIG. **35** except that it includes recesses **79z** which are fewer in number but wider in size. Also, the nose of the tip **27** at the distal end **85z** is accentuated in the embodiment of FIG. **37**.

It will be understood that many modifications can be made to the various disclosed embodiments without departing from the spirit and scope of the concept. For example, various sizes of the surgical device are contemplated as well as various types of constructions and materials. It will also be apparent that many modifications can be made to the configuration of parts as well as their interaction. For these reasons, the above description should not be construed as limiting the invention, but should be interpreted as merely exemplary of preferred embodiments. Those skilled in the art will envision other

modifications within the scope and spirit of the present invention as defined by the following claims.

What is claimed is:

1. A surgical obturator adapted to penetrate a body wall, comprising:
 - an elongate shaft extending along a longitudinal axis between a proximal end and a distal end; and
 - a bladeless tip at the distal end of the shaft; the tip includes a first region defined by a first cylindrical surface, a second region defined by a conical surface and a third region defined by a second cylindrical surface; the second region is located between the first region and the third region; the second cylindrical surface is located distally of the conical surface; and the conical surface transitions distally into the second cylindrical surface; the first cylindrical surface is located proximally of the conical surface; and the conical surface transitions proximally into the first cylindrical surface; and
 - the tip further includes ridges; the ridges extend radially outwardly in the second region and the third region; wherein the distal end is rounded.
2. The obturator of claim 1 wherein the ridges extend along the tip such that a major component of the ridges is parallel to the longitudinal axis.
3. The obturator of claim 1 wherein the obturator comprises a lumen open at a proximal end of obturator.
4. The obturator of claim 3 wherein the lumen is configured to receive a laparoscope therein.
5. The obturator of claim 1 wherein the tip is adapted to closely fit with the elongate shaft to facilitate a fixed but removable relationship between the elongate shaft and the tip.
6. A surgical obturator adapted to penetrate a body wall, comprising:
 - an elongate shaft extending along a longitudinal axis between a proximal end and a distal end; and
 - a bladeless tip at the distal end of the shaft; the tip includes a first region defined by a first cylindrical surface, a second region defined by a conical surface and a third region defined by a second cylindrical surface; the second region is located between the first region and the third region; the second cylindrical surface is located distally of the conical surface; and the conical surface transitions distally into the second cylindrical surface; the first cylindrical surface is located proximally of the conical surface; and the conical surface transitions proximally into the first cylindrical surface; and
 - the tip further includes ridges; the ridges extend radially outwardly in the second region and the third region; and
 - a cannula having a lumen extending between an open proximal end and an open distal end; the cannula is configured to receive the elongate shaft inside the lumen of the cannula.
7. A surgical obturator adapted to penetrate a body wall, comprising:
 - an elongate shaft extending along a longitudinal axis between a proximal end and a distal end; and
 - a bladeless tip at the distal end of the shaft; the tip includes a first region defined by a first cylindrical surface and a second region defined by a conical surface; the first region is located proximally of the second region; the conical surface transitions proximally into a first cylindrical surface; and the conical surface extends to the distal end; and
 - the tip further includes ridges; the ridges extend radially outwardly from the conical surface; each ridge having a proximal portion, an intermediate portion and a distal portion; the intermediate portion is located between the

11

proximal portion and the distal portion; the distal portion being distal to the intermediate portion; the proximal portion being proximal to the intermediate portion; the proximal portion and the distal portion of each ridge extend in planes passing through the longitudinal axis along the conical surface; and the intermediate portion of each ridge extends in planes that do not include the longitudinal axis; and

a cannula having a lumen extending between an open proximal end and an open distal end; the cannula is configured to receive the elongate shaft inside the lumen of the cannula.

8. A surgical obturator adapted to penetrate a body wall, comprising:

an elongate shaft extending along a longitudinal axis between a proximal end and a distal end; and

a bladeless tip at the distal end of the shaft; the tip includes a first region defined by a first cylindrical surface and a second region defined by a conical surface; the first region is located proximally of the second region; the conical surface transitions proximally into a first cylindrical surface; and the conical surface extends to the distal end; and

the tip further includes ridges; the ridges extend radially outwardly from the conical surface; each ridge having a proximal portion, an intermediate portion and a distal portion; the intermediate portion is located between the proximal portion and the distal portion; the distal portion being distal to the intermediate portion; the proximal portion being proximal to the intermediate portion; the proximal portion and the distal portion of each ridge extend in planes passing through the longitudinal axis along the conical surface; and the intermediate portion of each ridge extends in planes that do not include the longitudinal axis;

wherein the distal end is rounded.

9. The obturator of claim **8** wherein the obturator comprises a lumen open at a proximal end of obturator.

10. The obturator of claim **9** wherein the lumen is configured to receive a laparoscope therein.

12

11. The obturator of claim **8** wherein distally of the second region, the tip includes a third region defined by a second cylindrical surface.

12. The obturator of claim **8** wherein the tip is adapted to closely fit with the elongate shaft to facilitate a fixed but removable relationship between the elongate shaft and the tip.

13. A surgical obturator adapted to penetrate a body wall, comprising:

an elongate shaft extending along a longitudinal axis between a proximal end and a distal end; and

a bladeless tip at the distal end of the shaft; the tip includes a first region defined by a first cylindrical surface and a second region defined by a generally conical outer surface; the first region is located proximally of the second region; the conical outer surface transitions proximally into a first cylindrical surface; the conical outer surface extends distally; at least a portion of the conical outer surface along the longitudinal axis has a concave configuration; and

the tip further includes ridges extending radially outwardly from the conical outer surface; each ridge having a proximal end and a distal end; the distal end of each ridge transitions into the conical outer surface at the distal end; the proximal end of each ridge transitions into the first cylindrical surface at the proximal end; between the proximal end and the distal end, the ridges have a height that is increased in the location of the concave configuration of the conical outer surface;

wherein the distal end is rounded.

14. The obturator of claim **13** wherein the ridges extend along the tip such that a major component of the ridges is parallel to the longitudinal axis.

15. The obturator of claim **13** wherein the obturator comprises a lumen open at a proximal end of obturator.

16. The obturator of claim **15** wherein the lumen is configured to receive a laparoscope therein.

17. The obturator of claim **15** wherein the tip is adapted to closely fit with the elongate shaft to facilitate a fixed but removable relationship between the elongate shaft and the tip.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

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INVENTOR(S) : Edward D. Pingleton et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

IN THE SPECIFICATION

Column 8, line 65: Please delete "1010" and add --101o-- before in this embodiment

Signed and Sealed this
Third Day of May, 2016



Michelle K. Lee
Director of the United States Patent and Trademark Office